Ecological Overview for the Capital Springs Centennial State Park and Recreation Area

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Introduction

Project Purpose and Objectives

This report provides an ecological overview of the **Capital Springs Centennial State Park** and **Capital Springs Centennial Recreation Area**, a new project for the Wisconsin Department of Natural Resources. The Wisconsin Department of Natural Resources (WDNR), Bureau of Endangered Resources (BER) - Natural Heritage Inventory (NHI) section, initiated this study in the spring of 2002 to provide more and better information about the ecological resources of the area.

This ecological overview will support the master planning process by providing information to the public agency administrators, planners, and managers, and aiding the prioritization of sites and species for protection by public and private conservation organizations. The following report and accompanying Geographic Information System (GIS)-based maps were prepared to achieve the following short-term objectives:

- Conduct a biotic assessment of the study area.
- Compile a summary of existing environmental analyses of the study area.
- Identify sensitive areas based on occurrences of endangered resources.
- Recognize potential restoration and protection opportunities.
- Identify current and potential threats to sensitive areas.
- Provide an ecological overview for use in master planning.

Background

Wisconsin's first state park, Interstate State Park, was created in 1900. On Oct. 31, 2000, Wisconsin Governor Tommy G. Thompson announced the creation of two new state parks, in Marinette and Dane counties, to celebrate the centennial anniversary of the Wisconsin State Park System. The parks are Gov. Tommy G. Thompson Centennial State Park in Marinette County and Capital Springs Centennial State Park located on Lake Waubesa in the Town of Blooming Grove in Dane County.

"The Capital Springs property lies within 180 miles of 93 percent of the state population fulfilling one of the major goals established at the time the search began for a new state park," said George Meyer, then Secretary of the Department of Natural Resources. "We wanted to provide additional recreational opportunities close to the major population centers of the state and this property is perfect for that purpose" (WDNR 2000a).

The recently reauthorized Stewardship 2000 Fund, signed into law by former Governor Thompson, is the primary source of funding for the two new state parks.

Description of the Study Area

The project lies within the Madison metropolitan area in south central Dane County (see Map 1). The state park will make use of two new purchases of 326 acres of adjacent lands with 3,600 feet of shoreline on Lake Waubesa, formerly owned by Wisconsin Alumni Research Foundation and Lake Farm Park Associates. The property is composed primarily of agricultural fields with small amounts of woodlands, pasture, and wetlands. No improvements are present. Adjacent to this property is the existing 328 acre Lake Farm County Park that has recreational facilities including three shelters, a boat landing, trails, camping and picnic areas, a millennium tree nursery, and the Lussier Heritage Center. It is the intent of Dane County Parks and the WDNR to combine the new state property and the Lake Farm Park into one, jointly owned and managed state park named **Capital Springs Centennial State Park** encompassing 654 acres.

The new state park, in combination with the 2,400 acres of publicly owned land within the current Nine Springs E-Way (a Dane County park), will form the **Capital Springs Centennial Recreation Area** (CSCRA). The CSCRA is a collection of properties running from Upper Mud Lake near McFarland to Nevin Springs Wildlife Area, some five miles west. Ownership of the parcels within this corridor includes the cities of Monona, Madison, and Fitchburg, the towns of Blooming Grove and Dunn, the Madison Metropolitan Sewerage District (MMSD), and Dane County Parks. The area features a viewing platform overlooking the MMSD lagoons and the Monona Conservancy wetlands, the Capital City State Trail, WDNR Upper Mud Lake Fishery Area, WDNR Nevin Springs Fish & Wildlife Area, and the Jenni and Kyle Preserve. Each jurisdiction will continue to retain title to their agency's land/s. Two hundred and eight acres are proposed for later purchase as an addition to the Nevin Springs Fish & Wildlife Area , making the total future acreage of the CSCRA approximately 3,400 acres.

There are two uniting features of this long, narrow recreation corridor. One is the Capital Springs Trail, a hard-surface bicycle trail that currently runs nearly the entire length of the property and joins the Military Ridge and the Glacial Drumlin trails, linking Waukesha to Dodgeville. The second is the Nine Springs Creek Watershed that overlaps most of the CSCRA, joining the Yahara River just above Upper Mud Lake.

Geology

Bedrock in central Dane County consists of several hundred meters of sedimentary Cambrian sandstones overlaying Precambrian igneous and metamorphic rock. Just above the sandstone layer is an Ordovician cherty dolomite (limestone) of up of 60 meters in thickness called the Prairie du Chien group. These sedimentary rocks are between 550 and 450 million years old. They lay flat and level, with a very slight, 3-degree tilt to the south. These bedrocks were eroded and formed valleys essentially the same as areas of far western Dane County untouched by the glaciers. During the glacial period, these valleys were filled and the hills were covered by a variable layer of glacial till, more than 300 feet in some areas (Clayton & Attig, 1997). Olcott (1973) found till around the Nevin property to be 200 feet thick in some areas.

The eastern three-quarters of Dane County were covered by several continental glaciers during the Pleistocene. The study area falls within the glaciated region. Evidence from the deep oceans indicate that there have been over two dozen cold (glacial) and warm (interglacial) periods during the last 2.4 million years (UW-Madison Department of Geology & Geophysics, 2002). The Wisconsin Glaciation, the latest series of glacial advances and retreats, began about 25,000 years ago and ended in Dane County about 13,500 years before present (Clayton & Attig, 1997).

The Capital Springs Centennial State Park (CSCSP) and Capital Springs Recreation Area (CSRA) are located just east of the Johnstown moraine of the Green Bay lobe of the Wisconsin Glaciation. Several different types of glacial deposits occur within the study area (Clayton & Attig, 1997). Uniform glacial till consisting of gravel, clay and silty sand, surrounds areas of offshore lake sediment deposited in Glacial Lake Yahara. This glacial lake formed during the Lake Mills phase of the Wisconsin Glaciation and most likely lasted more than 1000 years. It was a very large lake formed by a blocked drainage of the Rock River. Silts and sands were laid on the lake bottom off shore and are from 1 to 25 meters in thickness. Postglacial marshes then deposited from 1 to 13 meters of peat on top of these sediments, with more recent marshes depositing up to three feet of marsh peat on top of older, sedimentary peat. This peat forms the soil in contemporary wetlands in the study area. A portion of the Nine Springs Creek watershed shows an area of presettlement stream sediment. This is an area where runoff from bare soil areas, most likely occurring soon after the last ice retreat, deposited mud in a similar fashion to flooding events we see today. An area of Lake Farm County Park shows where offshore sediment was deposited in a higher elevation and did not have later peat deposits. Generally, soils formed over these offshore sediments are not well drained (Clayton & Attig, 1997).

The glacial geology of Dane County and surrounding regions is famous among geologists the world over. Drumlins, moraines, eskers, glacial lakes, massive outwash plains, terraces, kettle lakes, and other features make this a region frequently visited by out-of-state geology students. The Ice Age National Scenic Trail runs just a few miles west of the CSCRA.

Hydrology

The hydrology of the 120 acre Nevin Springs Fish & Wildlife Area was studied from 1974 to 1976 by R.P. Novitzki (1978). At that time, the 460-acre drainage basin for this wetland was covered by 160 acres of woodland, 160 acres of agricultural crops, 70 acres of grassland, and 70 acres of “lightly used roads and parking areas, the hatchery buildings, and a few houses.” This study found that the inflow of this wetland was made up of 7 percent precipitation, 4 percent surface water, and 89 percent groundwater inflow. Some groundwater flowed beneath the wetland and discharged further east in the same watershed. In the case of the Nevin Springs, the ground watershed is much larger than the surface watershed (Olcutt, 1973 and Bradbury et al., 1995). This helps account for the large groundwater discharge forming the 20 or more springs of the area. Novitzki also found that the wetland retained 21 percent of the nitrogen input, 7 percent of the phosphorus, and a striking 80 percent of the sediment input. This shows the strong ability of the wetland, as it existed at that time, to filter water and trap nutrients (Novitzki, 1978).

Catherine R. Owen (1995) studied the hydrology of the Monona Conservancy wetlands, in the northeast section of the CSCRA, in 1990-1991. She found very little groundwater input and a very small groundwater recharge in this 92-hectare (227 acre) wetland. Human impact on this site was considered very high. Sixty-three percent of the 104-hectare drainage basin was paved. In the month June of 1991, 47 billion gallons of water were removed from the aquifer from one of two city pumping stations (Owen, 1995).

Owen determined that the 227 acre wetland had a flood storage capacity of 423,000 cubic meters (or 343 acre-feet) of water. The entire Upper Mud Lake and its surrounding marsh, including the Monona Conservancy site, can store 3,050 acre-feet of water in a 100-year flood. Her study also found the groundwater to be very high in calcium (30 to 41 parts per million) and magnesium (30 to 50 parts per million) with a pH of 7.61. These are typical of the values associated with the rare fen type of wetland found further west in the same watershed (Owen, 1995). Fens occur in areas where groundwater is being forced up through peat and carrying high levels of dissolved calcium and magnesium carbonates. Both the

glacial till layer and the groundwater of the study area are rich in calcium and magnesium, making this area potentially rich in fens.

Pavement and rooftops, impervious surfaces that result from development are a big concern in the study area. A study by WDNR researchers in 1997 showed the effect of urbanization on stream quality. They had previously developed a ranking of fish species based on tolerance or intolerance of any water pollution or water quality degradation. Fish data can be combined with stream conditions such as bank stability, natural vegetation along the stream, and other factors, to give an overall index of biotic integrity. The WDNR researchers collected data on stream fish species at 134 sites statewide, then used these data to compare streams, and correlate this with land use in the watershed. They found that high urban land use was strongly associated with poor biotic integrity and that a level higher than 10 percent to 20 percent urbanization consistently gave low biotic index scores (Wang et al. 1997).

Vegetation Prior to European Settlement: 1832-35

In addition to historical descriptions, the major source of information about the vegetation in the 1830's comes from the Public Land Survey records of the General Land Office (GLO). This survey established the township-range-section system of property description. In Dane County these surveys took place from 1832 to 1835. Starting at the border with Illinois the surveyors moved north marking every section and quarter-section corner with posts and nearby "witness" trees that served as semi-permanent legal markers for the corners. They recorded the diameter and species of each tree, as well as the distance and compass bearing from the post to tree. In addition, the surveyors recorded a general description of the land, making note of resources that could be exploited such as streams, timber, soils, and minerals. Sometimes they added notes about non-timber vegetation. Map 2 summarizes the vegetation of the study area prior to European settlement.

GLO field notes from the study area were examined. Tree species included black, white, and bur oaks with occasional hickory and aspen. Basswood and elm were notes on the western shore of Lake Waubesa, with ash (probably black ash) and tamarack noted on the east side of Upper Mud Lake. Undergrowth was usually noted as oak, hazel (American hazelnut – *Corylus americana*), and grasses. Frequent comments were "land rolling 2nd rate timber oak" with some notes as "land flat, mostly swamp." Nine Springs Creek was noted as 16.5 feet wide when crossed (twice) between sections 1, 2 and 3 in the Town of Fitchburg. Soils, when noted, were sandy loam to dark sandy loam.

In 1949, University of Wisconsin-Madison wildlife ecology professor Robert Ellarson used the GLO survey records to produce a map of Dane County's vegetation in 1835. The map shows almost the entire study area as either open marsh or oak opening (another term for oak savanna) (Ellarson, 1949). This type of map is often referred to as "presettlement" vegetation, a bit of a misnomer as south central Wisconsin was quite thoroughly settled by Native Americans prior to and even during this time (see historical context section).

A close examination of Ellarson's map clearly shows fire as the determining factor in the presettlement landscape. Fire-intolerant maple-basswood forest occurred only on the northeastern shores of the large lakes Mendota, Monona, and Kegonsa, areas that were sheltered on the leeward side of the lakes when hot, dry southwesterly winds carried fire across the landscape (Ellarson, 1949). Treeless prairie occurred mostly on level, deep soil terrain where growth was lush and the dry prairie grasses produced very hot fires that moved unchecked by landscape features. Thinner soils in hilly areas produced less fuel, and had cool, humid, north-facing slopes. Savanna landscapes occurred most often on the hilly terrain where the resulting cooler fires allowed some oak trees to survive (Ellarson 1949; Henderson, pers.comm.)

Landscape scale fire was common in the area up to the mid-1800s, when prairie fires were still reported on the isthmus of Madison (Mollenhoff, 1982).

Current Land Use and Land Cover

The study area lies within the Lake Monona/Lake Waubesa watershed, which is a sub-drainage of the Yahara River. Table 1 provides a summary of land cover for the Lake Monona/Lake Waubesa watershed, and Table 2 shows land cover for the study area.

Table 1 Summary of WISCLAND Land Cover of the Lake Monona/Lake Waubesa Watershed

Level1	Level2		Acres	% of Watershed
URBAN/DEVELOPED	101	High Intensity Developed	9,535	15.9%
	104	Low Intensity Developed	8,914	14.9%
	105	Golf Course	690	1.2%
			19,139	**31.9%**
AGRICULTURE	111	Herbaceous/Field Crops	**13,303**	**22.2%**
GRASSLAND	150		**9,299**	**15.5%**
FOREST	161	Coniferous	144	0.2%
	175	Broad-Leaved Deciduous	5,039	8.4%
			5,184	**8.6%**
OPEN WATER	200		**6,372**	**10.6%**
WETLAND	211	Emergent/Wet Meadow	3,442	5.7%
	217	Lowland Shrub	537	0.9%
	222	Forested	1,182	2.0%
			5,161	**8.6%**
BARREN	240		**1,485**	**2.5%**

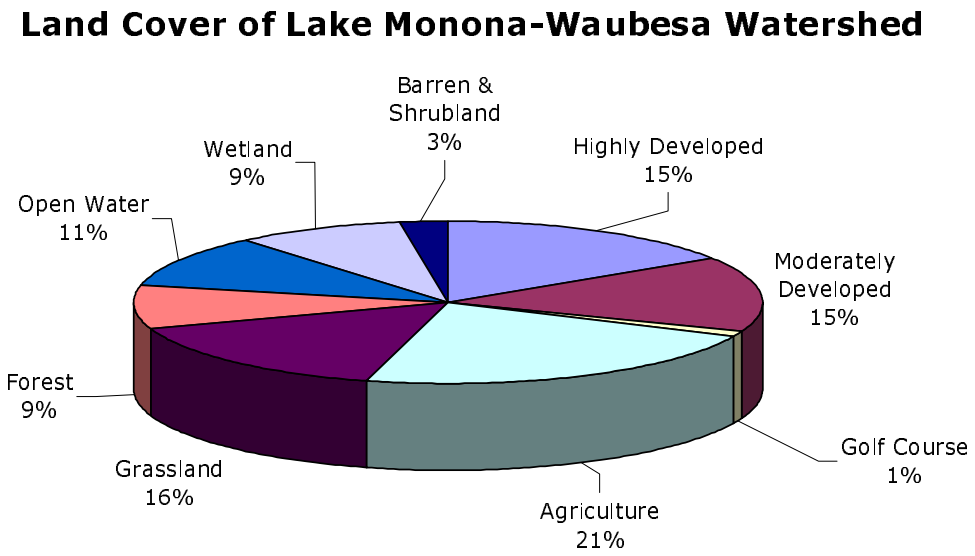
		TOTALS:	**59,984**	**100.0%**

Table 2 Summary of WISCLAND Land Cover of the Study Area

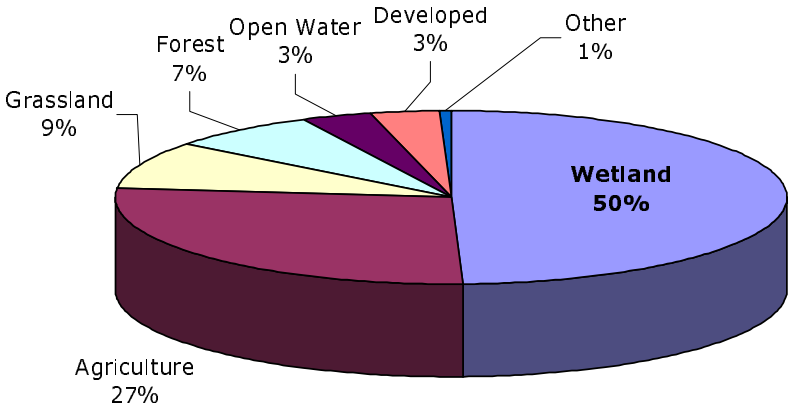
Level1	Level2	Acres	% of Study Area	% of Watershed
URBAN/DEVELOPED	High Intensity Developed	61.2	2.0%	0.1%
	Low Intensity Developed	35.7	1.2%	0.1%
		96.9	**3.2%**	**0.2%**
AGRICULTURE	Herbaceous/Field Crops	**830.9**	**27.3%**	**1.4%**
GRASSLAND		**272.7**	**9.0%**	**0.5%**
FOREST	Coniferous	9.5	0.3%	0.0%
	Broad-Leaved Deciduous	214.0	7.0%	0.4%
		223.5	**7.3%**	**0.4%**
OPEN WATER		**100.8**	**3.3%**	**0.2%**
WETLAND	Emergent/Wet Meadow	1177.3	38.6%	2.0%
	Lowland Shrub	111.9	3.7%	0.2%
	Forested	213.7	7.0%	0.4%
		1502.9	**49.3%**	**2.5%**
BARREN		**17.7**	**0.6%**	**0.0%**
SHRUBLAND		**0.7**	**0.0%**	**0.0%**

TOTALS:	**3046.0**	**100.0%**		**5.1%**

The following pie charts summarize the tables above.



Land Cover of the Study Area



The land surrounding the study area has been intensively urbanized during the last few decades. Between 1980 and 1990, 840 acres were developed in the City of Fitchburg (which borders the study area to the south), a 24 percent increase in total developed area (Water Resources Management Practicum (WRM), 1996). The rapid development trend is expected to continue. U.S. Census data for 2000 shows that Dane County population increased 16.2 percent between 1990 and 2000 while Fitchburg increased at a rapid 31 percent during this same period (U.S. Census Bureau website, State of Wisconsin Blue Book 2001-2002 website). In addition, Catherine Owen (1995) studied the hydrology of the Monona Conservancy (northeast section of the CSCRA) in 1990-1991 and reported that 63 percent of the 257-acre drainage basin was paved. Map 3 shows the current land cover of the study area at WISCLAND level 2.

Vegetation

Wetlands

The wetlands of the Capital Springs Centennial State Park and Recreation Area 100 years ago were primarily southern sedge meadow in the western sector and shallow marsh in the eastern sector near Upper Mud Lake. The sedge meadow area was large and yet typical of many large sedge meadows in the eastern half of Dane County. Dominants were tussock sedge (*Carex stricta*) and bluejoint grass (*Calamagrostis canadensis*) (Stout, 1914). The wetlands were fed by an unusually high number of springs, some of which with comparatively high flow rates (WRM 1996, Novitzki 1978, Nurre 2002). These sedge meadows were maintained by fire and soil saturation that discouraged invasions by shrubs, but also by the common use of these areas as hay meadows. Marsh hay was considered quite valuable in former times, and local Fitchburg farmers sometimes bought strips of marshland even a couples miles from their cabins to provide hay for livestock (Kinney, 1993). In the 1830's these southern sedge meadows and marshes were thriving, productive ecosystems filled with bird life, frogs, snakes, and turtles. Sandhill and whooping cranes used such marshes, as did herons, egrets, bitterns, snipe, Wilson's phalarope, rails, coots, short-eared owls, harriers, and ducks (Mossman and Sample 1990, Volkert 1999, Cahn 1916).

With plowed fields and closely cropped pastures providing large firebreaks, wildfires ceased in the Madison area in the 1880's (Mollenhoff, 1982). Draining of the Nine Springs wetlands began in the early 1900's (Frolick, 1941). Unburned and drained sedge meadows rapidly convert to shrub-carrs with many disturbance species (Vogl 1969, White 1965). Reed canary grass became a major invader of the Nine Springs wetlands by 1974 (Bedford 1974, Hansen 1975) and has increased ever since. The WRM study (1996) found that non-degraded wetland areas have shrunk by approximately 70 percent since 1974.

The study area was surveyed on several occasions in April and May of 2002 for this report. An in depth survey of several wetland areas was conducted May 10, 2002. Conditions were found to be much as reported in several previous studies (WDNR 1999, WRM 1996, Hansen 1975). Some pockets of high quality, relatively undisturbed sedge meadow still occur in the western sector. These small areas had water levels that are desirable for this habitat and had good plant diversity. Most disturbance in these areas appeared to be caused by white-tailed deer. Marsh marigolds (*Caltha palustris*) were in bloom throughout these areas. Dominant species varied with some areas being dominated by tussock sedge (*Carex stricta*), some by lake sedge (*Carex lacustris*), and others by bluejoint grass (*Calamagrostis canadensis*). Birds observed included common yellowthroat and swamp sparrow. Large areas of cattail marsh occur near Nine Springs Creek. These appear to be somewhat monotypic and invaded by shrubs. They suffer from large floods that now occur (WRM 1996), lack of fire, and lack of muskrats that might

create more open areas. These marshes, even as early as May 10 had good sora rail (a wetland bird) populations. Along the bike trail just west of Syene Road there appear to be areas with fen attributes. It was too early to observe fen sedges such as *Carex sterilis* seen by other observers (Cochrane, 1999). However, bog birch (*Betula pumila*) was observed and this is often a fen indicator in southern parts of the state (personal obs.).

Disturbed areas were marked in some areas by a near total dominance of reed canary grass, and in other areas by dense shrub-carr composed primarily by red osier and gray dogwoods (*Cornus stolonifera, C. racemosa*), Eurasian honeysuckles (*Lonicera tartarica, L. morrowii, L. X bella*), with scattered Bebb's willow (*Salix bebbiana*) and box elder (*Acer negundo*). Large, straight drainage ditches have sizable spoil banks that are densely covered with buckthorn (*Rhamnus cathartica*). These ditches carry sufficient water to alter significantly the hydrology of the area. One disturbing aspect has been an apparent increase since the 1970's in common reed (*Phragmites australis*). This has become quite invasive in many wetlands all over the eastern United States. Research is currently being done to determine the genetic origin of the invasive strain of this native grass (Kelly Kearns, Bureau of Endangered Resources, pers. communication).

The vegetation of the Monona Conservancy wetlands appears to still be in relatively good condition with a variety of types varying from sedge meadow to floating sedge and cattail mat to shallow and deep-water marsh. Some reed canary grass has invaded from the area around South Towne Road and the South Beltline. Ditches and berms have grown tall, narrow stands of cottonwood, willow, and box elder. Common reed appears to be somewhat on the increase, but not reaching the level of an aggressive invader. The area east of Upper Mud Lake is rapidly filling in with shrubs.

Uplands

The uplands are now mostly developed with streets and buildings. However, large areas agricultural fields, upland brush, pine and white cedar plantations, and small, disturbed woodlots still remain. Upland brush habitats appear to be all abandoned pastures that once were covered with Kentucky bluegrass (*Poa pratensis*) and are now in various stages of being completely taken over by Eurasian honeysuckles. Some small shrub free areas are densely weedy with burdock (*Arctium minus*) or Canada goldenrod (*Solidago canadensis*). Woodlands are described in the next section (p. 15).

The vegetation of the Capital Springs Centennial State Park is almost entirely current crop fields or recently cropped fields. A small woodland with light commercial and residential development is located in the northwest corner, just east of Lake Farm Road. Small areas of mixed deciduous woodlands fringe the shore of Lake Waubesa. Just west of the small peninsula within the park area is an open pasture with possibly some remnant prairie vegetation on a small glacial drumlin. In the southeast portion next to the lake is small wetland of mixed emergent aquatic and sedge meadow vegetation. Just west of this is a very small mixed deciduous woodland.

Community Type Descriptions

The descriptions below are based on Natural Heritage Inventory community types (January 2001 revision), with some additions and typographic changes. The list includes one additional type, the *Floating Mat of Sedge and Cattail*, that is not well covered by NHI types. Following each general description is a summary of the condition and extent of the community type within the study area as observed on a field observation of May 10, 2002, or by published papers cited in the text.

Wetlands

Calcareous Fen
A rare, open wetland found in southern Wisconsin, often underlain by a calcareous substrate or marl, through which percolates carbonate-rich groundwater percolates. The flora is typically diverse, with many calciphiles. Common species are several sedges (*Carex sterilis* and *C. lanuginosa*), marsh fern (*Thelypteris palustris*), shrubby cinquefoil (*Potentilla fruticosa*), shrubby St. John's-wort (*Hypericum kalmianum*), Ohio goldenrod (*Solidago ohioensis*), grass-of-Parnassus (*Parnassia glauca*), twig-rush (*Cladium mariscoides*), brook lobelia (*Lobelia kalmii*), boneset (*Eupatorium perfoliatum*), swamp thistle (*Cirsium muticum*), and asters (*Aster* spp.). Some fens have significant prairie or sedge meadow components, and appear to intergrade with those communities. Carpenter (1995) found only 55 calcareous fens in Wisconsin.

Extent and Condition: Along the bike trail just west of Syene Road there appear to be areas with fen attributes (May 10, 2002 field observations). It was too early to observe fen sedges such as *Carex sterilis* seen by other observers (Cochrane 1999, Arnold et al. 1999). However, bog birch (*Betula pumila*) was observed and this is often a fen indicator in southern areas (personal obs.). These areas appear to be no more than a few acres and were in relatively good condition. Another area just east of Syene road and north of Nine Springs Creek was labeled as fen by Schmitt and Voss (1997) but no specific evidence was given for this designation. This is also several acres in extent.

Emergent Aquatic
These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust emergent macrophytes, in pure stands of single species or in various mixtures. Dominants include are often species of cattails (*Typha* spp.), bulrushes (particularly *Scirpus acutus, S. fluviatilis*, and *S. validus*), bur-reeds (*Sparganium* spp.), common reed (*Phragmites australis*), water-plantains (*Alisma* spp.), arrowheads (*Sagittaria* spp.), and the larger species of spikerush such as (*Eleocharis smallii)*.

Extent and Condition: Approximately 300 acres of the Monona Conservancy wetlands in the northeast section of the study area are this type, varying from more diverse between the lagoons and Upper Mud Lake to monotypic cattail or reed grass stands near the MMSD lagoons. This type also occurs west of Syene Road along Nine Springs Creek as fairly monotypic cattail stands being invaded by shrubs in many areas. They appear to suffer from various hydrological disturbances (May 10, 2002 field observation).

Floating Mat of Sedge and Cattail

This is a proposed new type that is not well covered by current NHI descriptions, and often combines floristically *Emergent Aquatic* type and *Southern Sedge Meadow* community. Though often strong

enough to walk on, these treeless, floating sedge mats will bounce and wiggle like a worn out trampoline, and often allow the wetland explorer to fall through to the waist. They may be nearly to completely submerged in early spring and are usually, though not always, near open water.

The mat matrix is held together by the rhizomes of a combination, either together or separately, of lake sedge (*Carex lacustris),* wire-leaved sedge (*Carex lasiocarpa*), long-bracted tussock sedge (*Carex aquatilis*), and broad-leaved or narrow-leaved cattail (*Typha latifolia or T. angustifolia*). Frequent associates include Canada bluejoint grass (*Calamagrostis canadensis*). Other associates include sweet flag (*Acorus calamus*), bulb-bearing water hemlock (*Cicuta bulbifera*), blue flag (*Iris virginica*), water horehound (*Lycopus uniflorus*), tufted loosestrife (*Lysimachia thyrsiflora*), smartweeds (*Polygonum amphibium, P. punctatum.*), great water dock (*Rumex orbiculatus)*, arrowhead (*Sagittaria latifolia.*), water parsnip (*Sium suave*), and bur-reed (*Sparganium eurycarpum*). Good examples in Dane County include large sections of Waunakee marsh, Hook Lake, and Lodi marsh. (For an example see Bedford et al., 1974 p. 541, area 7).

Extent and Condition: Approximately 20 acres of the Monona Conservancy wetlands in the northeast section of the study area appear to be this type (Owen et al, 1989).

Shrub-Carr

This primarily southern wetland community is dominated by tall shrubs such as red-osier dogwood (*Cornus stolonifera*), but meadow-sweet (*Spiraea alba*) and various willows (*Salix discolor, S. bebbiana*, and *S. gracilis*) are frequently also important. Canada bluejoint grass (*Calamagrostis canadensis*) is often very common. Other herbaceous associates are similar to those found in Alder Thickets and tussock-type Sedge Meadows. This type is common and widespread in southern Wisconsin but also occurs in the north. The classic paper on this type is White, K.L. 1965. *Shrub Carrs of Southeastern Wisconsin*. Ecology 46:286:303. White examined 175 stands finding only 8 sites that had been undisturbed in the previous 20 years, and none that were undisturbed greater than 35. He found 192 plant species including 38 species of shrubs. He states that all wet meadows require mowing, grazing, or burning, or they will be rapidly colonized by shrubs.

Extent and Condition: Many areas of former open sedge meadow are now shrub-carr (May 10, 2002 field observation). Schmitt and Voss (1997) provide air photos of the "Syene Road Fen" from 1980 and 1990 showing a dramatic invasion of shrubs correlated with altered hydrology due to development in the immediate vicinity. In the wetland portion of the 1980 photo a few small shrubs are barely visible west of the spring outlet. In the 1990 photo this approximately 4 acre section is nearly totally dominated by a dense stand of shrubs, with many scattered shrubs appearing east of the spring outlet. Approximately 100 acres of shrub-carr occur in the study area.

Southern Sedge Meadow

Formerly widespread in southern Wisconsin, this open wetland community is most typically a tussock marsh dominated by tussock sedge (*Carex stricta*) and Canada bluejoint grass (*Calamagrostis canadensis*). Common associates are water horehound (*Lycopus uniflorus*), panicled aster (*Aster lanceolatus*), shining aster (*Aster firmus* or *A. lucidulus*), blue flag (*Iris virginica*), goldenrods (*Solidago canadensis* if weedy, *Solidago gigantea*), spotted Joe-Pye-weed (*Eupatorium maculatum*), broad-leaved cattail (*Typha latifolia*), and swamp milkweed (*Asclepias incarnata*). There are also broad-leaved sedge meadows, dominated by the robust sedges (*Carex lacustris)* and wire-leaved sedge meadows, dominated by such species as woolly sedge (*Carex lasiocarpa*). Frequent associates include marsh bluegrass (*Poa palustris*), manna grasses (*Glyceria* spp.), and the bulrushes *Scirpus atrovirens* and *S. cyperinus*. The classic study of this type is Stout (1914).

Reed canary grass (*Phalaris arundinacea*) may be dominant in grazed and/or ditched stands. Ditched stands can succeed quickly to Shrub-Carr. Studies show that trees and shrubs were kept out partly because the high water tables did not allow their roots to grow as well, and partly because, just as low prairies, these areas burned almost every year (White 1965, Vogl 1969). Sedge meadows are highly flammable in the spring and have a dry layer of duff held above the water (personal obs.).

Extent and Condition: Some pockets of high quality, relatively undisturbed sedge meadow still occur in the western sector (May 10, 2002 field observation). These small areas were quite wet and had good diversity. Most disturbance in these areas appeared to be caused by white-tailed deer. Marsh marigolds were in bloom throughout these areas. Dominant species varied with some areas being dominated by tussock sedge (*Carex stricta*), some by lake sedge (*Carex lacustris*), and others by bluejoint grass (*Calamagrostis canadensis*). Birds observed included common yellowthroat and swamp sparrow. Approximately 50 acres of this type remains.

Submergent Aquatic
This herbaceous community of aquatic macrophytes occurs in lakes, ponds, and rivers. Submergent macrophytes often occur in deeper water than emergents, but there is considerable overlap. Dominants include various species of pondweeds (*Potamogeton* spp.) are dominant along with waterweed (*Elodea canadensis*), slender naiad (*Najas flexilis*), eel-grass (*Vallisneria americana*), and species of water-milfoil (*Myriophyllum*) and bladderworts (*Utricularia*).

Extent and Condition: Approximately 50 acres of this type is presumed to occur primarily along the shores of Upper Mud Lake and Lake Waubesa (not field checked for this study). A boat would be needed to observe this community. These lakes have very high boat and jet ski usage in the summer that would likely disturb and modify this plant community. Eurasian water milfoil (*Myriophyllum spicatum)* is common in Madison lakes and is likely to dominate portions of this community.

Tamarack (rich) Swamp (formerly called Tamarack Fen)
This forested wetland community type is a variant of the Tamarack Swamp, but occurs south of the Tension Zone within a matrix of "southern" vegetation types. Poison sumac (*Toxicodendron vernix*) is often a dominant understory shrub. Successional stages and processes are not well understood but fire, wind throw, water level fluctuations, and periodic infestations of larch sawfly are among the important dynamic forces influencing this community. Groundwater seepage influences the composition of most if not all stands. Where the substrate is especially springy, skunk cabbage (*Symplocarpus foetidus*), marsh marigold (*Caltha palustris)*, sedges, and a variety of mosses may carpet the forest floor. Drier, more acid stands may support an ericad and sphagnum dominated groundlayer.

Extent and Condition: This type was observed east and northeast of Upper Mud Lake by Bedford et al (1974). It was described as tamarack (*Larix laricina)* with bog birch (*Betula pumila*), alder (Alnus incana), red-osier dogwood (*Cornus stolonifera*), and willows on tussock sedge (*Carex stricta*) with reed canary grass moving in. It covers approximately 80 acres. The area could not be field checked for this study. The 1993 air photos show a large area of dense shrub-carr with scattered trees and some open sedge areas.

Uplands

Oak Woodland
This forest community is structurally intermediate between Oak Openings and Southern Dry Forest. The tree canopy cover is more than 50 percent, but frequent low-intensity fires and possibly (in pre-settlement times) browsing by herbivores such as elk, bison, and deer kept the understory relatively free of shrubs and saplings. Additional information is needed but it appears that at least some plants (certain legumes, grasses, and composites among them) reached their highest abundance here.

Extent and Condition: Woodland areas are still dominated by mature bur, white and black oak in the canopy (May 10, 2002 field observation). Some 42-inch diameter white and bur oaks (age estimate 200 years or more) remain, though nearly buried in the dense forest. Large, mature shagbark hickory are also common. Subcanopy layers are very dense with box elder and black cherry with a dense shrub layer primarily of Eurasian honeysuckle species. These cast sufficient shade to create, in combination with excessive deer browse, a depauperate understory with few native woodland species. Some woodland and savanna restoration is in process under the direction of Dane County Parks. This involves extensive clearing of all subcanopy, non-oak woody species in a good stand of mature white oaks.

Methods

Interviews and Contacts

Local experts on the CSCSP and CSCRA were interviewed. Interviewees represented a wide range of expertise included wetland biology, ecology, hydrology, geology, parks management, restoration ecology, history, and parks planning. A list of contacts is included following the references section. In addition, material in the form of property master plans and past studies of the area was collected and reviewed.

Information Searches

In addition to direct interviews, searches of several databases were conducted for scientific studies of the area. The University of Wisconsin-Madison library system was used to query several databases: Bio-abstracts (covers all biology related journals, 1980-present), JSTOR (covers ecology and botany, about 30 journals, 1867 to 1998.), and a special, UW proprietary facsimile collection of the Transactions of the Wisconsin Academy of Science, Arts and Letters, 1970 to 2000. The Wisconsin Department of Natural Resources library catalogue and the Wisconsin Breeding Bird Atlas database, housed at the University of Wisconsin-Green Bay, were also queried.

Field Surveys

A roadside survey of the study area was conducted in April of 2002 for this report, ground truthing the aerial photos and determining overall ecological condition for the study area. An in-depth field survey of several wetland areas was conducted May 10, 2002.

Natural Heritage Inventory Data

The WDNR BER maintains an extensive database of natural communities, and rare plants and animals through the Wisconsin Natural Heritage Inventory program, part of an international network of Heritage programs coordinated by NatureServe. The database is composed of *Element and Element Occurrence (EOs)*. Elements are defined as "*rare* or *declining* species, *high-quality*, *rare*, or otherwise *significant* natural communities, and *unique* or *significant* natural features" (WDNR, 1998, emphasis in original). NatureServe, in its 2002 *Draft Element Occurrences Data Standard*, defines an EO as the following:

> *An area of land and/or water in which a rare species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historic) presence and/or regular recurrence at a given location. For species, the EO often corresponds with the local population, but when appropriate may be a portion of a population (e.g., a single nest territory or long distance dispersers) or a group of nearby populations (e.g., metapopulation). For communities, the EO may represent a stand or patch of a natural community or a cluster of stands or patches of a natural community. Because they are defined on the basis of biological information, EOs may cross jurisdictional boundaries.*

A search of the NHI database yielded 13 element occurrences (EOs) within 5 miles of the CSCRA. Table 3 lists individual species. No EOs were found that were recent enough to allow the precision needed to determine that they occurred within the study area. Older records are considered to have a five-mile accuracy.

State Status

END= Endangered, that which is in danger of becoming extinct in the state. THR= Threatened, in danger of becoming endangered. SC= Special Concern. Special Concern species are those about which some problem of abundance or distribution is suspected but not yet proven.

Srank

S1= Critically imperiled in Wisconsin because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2= Imperiled in Wisconsin because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3= Rare or uncommon in Wisconsin (21 to 100 occurrences) (WDNR 2000c).

Table 3 NHI Element Occurrences within Five Miles of the Capital Springs Study Area

Scientific Name	Common Name	Last Obs.	Srank	State Status	Group (1)
Microtus ochrogaster	Prairie Vole	1948	S2	SC/N	Mammal
Agastache nepetoides	Yellow Giant Hyssop	1922	S2	THR	Plant
Arabis shortii	Short's Rock-Cress	1877	S2	SC	Plant
Asclepias purpurascens	Purple Milkweed	1907	S2	END	Plant
Calamagrostis stricta	Slim-Stem Small-Reedgrass	1907	S3	SC	Plant
Cypripedium candidum	Small White Lady's-Slipper	1880	S3	THR	Plant
Echinacea pallida	Pale-Purple Coneflower	1937	S2S3	THR	Plant
Nothocalais cuspidata	Prairie False-Dandelion	1902	S2	SC	Plant
Orobanche uniflora	One-Flowered Broomrape	1883	S3	SC	Plant
Parthenium integrifolium	American Fever-Few	1907	S2	THR	Plant
Polytaenia nuttallii	Prairie Parsley	1916	S2	THR	Plant
Scirpus pallidus	Pale Bulrush	1909	SH	SC	Plant
Silene nivea	Snowy Campion	1880	S2	THR	Plant

GIS Information Sources

GIS Data Layers Distributed by WDNR:

- County Boundaries, Roads, Highways, Municipalities
- WISCLAND Land Cover Classification
- 75-meter Digital Elevation Model
- Digital Ortho-photography
- 1:100K and 1:24K Hydrology
- Original Vegetation Cover
- State Lands
- Surficial Deposits
- Bedrock Type
- Bedrock Depth
- Sections, Subsections, Landtype Associations (from LTA Disk 2.1)
- Ecological Landscapes
- 1:24K USGS DRGs

Data Provided by NHI:

- Element Occurrences (point and polygon themes)
- Element Occurrence descriptions

Non-Digital Sources:

- 1:15,840 black and white infrared aerial photography
- USGS 1:24,000 topographic maps
- NHI 1999 Biotic Overview Report

WISCLAND Land Cover Classification

The Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND) collected land cover data for the entire state using Landsat Thematic Mapper (TM) satellite imagery between 1991 and 1993. Landsat imagery is composed of pixels, each one representing a 30 by 30 meter square on the ground. Each pixel is assigned a value based on its spectral reflectance, and each value is associated with a different land cover type based on the known "spectral signature" of that type. By lumping or splitting associated cover types, we can use WISCLAND to map land cover at different scales and resolutions. The final WISCLAND dataset (which uses a three-level hierarchical classification scheme) is distributed as an ARC/INFO grid file that was quantitatively analyzed using ArcView's Spatial Analyst extension.

Identification of Ecologically Significant Sites

Previous studies and documents of all types were searched for existing or potential high quality wetland vegetation, even in very small pockets. These were then located on the digital orthophoto and USGS layers and checked for current condition using 1993, 1:15,840 black and white infrared aerial photographs. Areas now covered by monotypic stands of reed canary grass were avoided, as were developed and agricultural areas. A roadside survey of the study area was conducted in April of 2002 for this report, ground truthing the aerial photos and determining overall ecological condition for the study area. An in depth survey of several wetland areas was conducted May 10, 2002. This survey allowed a more precise determination of the conditions of many small areas including hydrology, vegetation, birds present, and disturbance features. Most of the uplands were found to be too disturbed to be considered high quality. The one exception is a small, reconstructed mesic prairie at Lake Farm County Park.

Results

After interviewing experts, evaluating previous studies and 1993 aerial photographs, and conducting field surveys, we identified nine sites with potential to have within them some high quality areas with a diversity of native vegetation and reasonable potential for the finding of state-listed species (see Map 4). Despite numerous cursory studies, no rigorous plant surveys have ever been done for many potentially high quality areas.

Site ID	Site Name	Acres	USGS Quad	T-R-S
1	Nevin Springs	67	Madison West	6-9-10

This site includes S*outhern Sedge Meadow* and potentially *Calcareous Fen* communities (May 10, 2002 field observation). Reed canary grass and other disturbance vegetation dominate many areas. However there are many good pockets of remnant tussock sedge meadow with stands of tussock sedge (*Carex stricta*), and lake sedge (*Carex lacustris*). On May 10th there were many areas of marsh marigold (*Caltha palustris*) and marsh violet (*Viola cucullata*) in bloom. Angelica (*Angelica atropurpurea*) is common and fen thistle (*Cirsium muticum*) was found. The eastern-most area abuts search site #2 across from a north-south running spring outlet. This area was noted by Hansen (1975) as one of the highest quality areas in the Nine Springs E-Way. The May 10th observation confirmed this impression.

Site ID	Site Name	Acres	USGS Quad	T-R-S
2	Bike Trail Fens	62	Madison West	6-9-2, 3

This site includes *Southern Sedge Meadow* and potentially *Calcareous Fen* communities (May 10, 2002 field observation). Arnold et al. (1999) noted fen areas here. Ted Cochrane (1999) conducted a brief survey and found good patches of *Carex sterilis*, a key fen indicator. He stated, "Surely, additional calcareous fens are yet to be discovered in this area." Some of the areas are degraded with reed canary grass or other non-native vegetation. The western-most area abuts site #1. Hansen (1975) noted some of this area as a high quality sedge meadow. The May 10th observation found areas of marsh marigold (*Caltha palustris*) and marsh violet (*Viola cucullata*) in bloom.

Site ID	Site Name	Acres	USGS Quad	T-R-S
3	Shrubby Cattail Marsh	36	Madison West	6-9-2

This site is a cattail marsh and includes *Emergent Aquatic and Shrub-Carr* communities (May 10, 2002 field observation). It is marked as emergent aquatic and sedge meadow on BER 1999 map (WDNR, 1999). Hansen (1975) noted portions of this area as a high quality. The area had good sora rail and mallard populations on the May 10th field observation.

Site ID	Site Name	Acres	USGS Quad	T-R-S
4	Jenni and Kyle Preserve Marsh	25	Madison West	6-9-2

This site is a cattail marsh with a *Shrub-Carr* invading from the north. It is marked as emergent aquatic on BER map (WDNR 1999). A bird census may be more likely than plant surveys to locate interesting native species. The flora is fairly monotypic, but with good structure and hydrology for birds.

Site ID	Site Name	Acres	USGS Quad	T-R-S
5	Syene Road Fen	33	Madison West	6-9-2

This area includes springs, S*outhern Sedge Meadow* and *Shrub-Carr* (May 10, 2002 field observation). The spring is still very active although hydrology has changed considerable in the last 20 years due to development (Schmitt and Voss, 1997). The May 10th, 2002 field observation found an extensive, high quality stand dominated by bluejoint grass (*Calamagrostis canadensis*), the largest bluejoint meadow in the study site. This indicates the area was used for marsh hay perhaps longer than other areas. Often if these sites are burned, they yield interesting species (Swink and Wilhelm, 1994. See entry for *Cypripedium calceolus var. parviflorum*). This site has the potential for small white lady's-slipper (*Cypripedium candidum)* (pers. obs.) after a burn. Shrub-carr is invading from the north.

Site ID	Site Name	Acres	USGS Quad	T-R-S
6	Monona Conservancy West	97	Madison East	7-10-29

This site includes *Emergent Aquatic*, *Southern Sedge Meadow,* and *Floating Sedge and Cattail Mat* communities. This area remains unexplored as it is accessible only after a long walk down the railroad track, or from the Yahara River. No studies or plant lists were found for this area.

Site ID	Site Name	Acres	USGS Quad	T-R-S
7	Monona Conservancy East	85	Madison East	7-10-29, 28

This site includes *Emergent Aquatic*, *Southern Sedge Meadow,* and *Floating Sedge and Cattail Mat* communities. This area remains unexplored as it is accessible only after a long walk down the railroad track or in from the south, or from the Yahara River. No studies or plant lists were found for this area. A search approach for Sites 6 & 7 would be to locate and flag sedge mats within the cattail—reed grass matrix in the winter when the site is frozen. These areas could be quickly relocated in the summer. Sedge mats within emergent aquatic communities often yield interesting native species. One listed species that may be sought in this setting is meadow cuckoo flower (*Cardamine pratensis*). A bird census may also yield listed species. Blanding's turtle may also be present.

Site ID	Site Name	Acres	USGS Quad	T-R-S
8	Upper Mud Lake Wetlands	76	Madison East	7-10-28

Includes *Southern Sedge Meadow & Tamarack (rich) Swamp* (formerly called *Tamarack Fen*). This existed along the east side of Upper Mud Lake in 1974. It was described by Bedford and Zimmerman (1974) as tamarack (*Larix laricina)* with bog birch (*Betula pumila*), alder (*Alnus incana*), red-osier dogwood (*Cornus stolonifera*), and willows (*Salix spp.*) on tussock sedge (*Carex stricta*). They noted that reed canary grass was moving in. This site includes "reference area 4" from Owen et al. (1989) that had a rich list of species including the state special concern (S1) sedge *Carex suberecta*. This area was not surveyed in the May 10th, 2002 field observation.

Site ID	Site Name	Acres	USGS Quad	T-R-S
9	State Park Drumlin & Shores	64	Madison East	7-10-32

Small areas of mixed deciduous woodlands fringe the shore of Lake Waubesa and form a distinctive peninsula of land jutting east into the lake. Just west of the small peninsula is a glacial drumlin with an open pasture with possibly some remnant prairie vegetation. In the southeast portion next to the lake is a small wetland of mixed emergent aquatic and sedge meadow vegetation. Hansen (1976) noted the wetland to be "a very excellent small marsh and sedge meadow." Just west of this is a very small mixed deciduous woodland. This area was not surveyed in the May 10th, 2002 field observation.

Restoration and Protection Opportunities

The Value of Wetlands and Native Communities

The Capital Springs Centennial State Park and Recreation Area is a wetland rich environment with considerable potential for wetland restoration. Wetlands provide a variety of important ecological benefits. They play a major role in maintaining a well-functioning hydrologic cycle by retaining rainwater, buffering spring floods, recharging groundwater, and filtering sediment and agricultural runoff. Wetlands also provide essential habitat for many plants and animals. Non-forested wetlands often represent the only large, open, uncultivated vegetation communities on the landscape; many species, especially birds, require such large habitat blocks. Wetlands also represent some of the best intact remnants of Wisconsin's presettlement vegetation. Because they are less attractive to commercial development, wetland communities such as shallow marsh and sedge meadows have persisted on the Wisconsin landscape since the retreat of the continental glaciers. While other native communities such as prairies and white pine forests have been reduced to less than one percent of their pre-European settlement acreage, about half of Wisconsin's original wetlands have survived (Thompson & Luthin, 2000). A diverse sedge meadow retains many of its original species, and acts as a potential standard for diversity that should be found in remnants of other native plant communities (see Leach and Givnish, 1999).

Wetlands and natural areas in an urban environment provide direct human benefits such as a sense of space, natural vistas, opportunities for wildlife and wildflower viewing and photography, bird watching, hiking, cross-country skiing, and snowshoeing. Oak savannas and prairies teach us about the interaction of fire, climate, soil, native species, phenology, herbivores, insects, drought adaptations, and many other natural processes. Looking from a broader perspective, because southern Wisconsin has protected wild habitats more than some surrounding states, our higher bird populations here may be crucial to restocking areas near our borders. As neo-tropical migrants are showing sharp declines in many states, our protection of bird habitat in Wisconsin becomes all the more important.

The Value of Restoration

Restoration of native plant communities gives the public a sense of history and a feeling of belonging to an ecological as well as a social community, an idea pioneered by Aldo Leopold. The science of ecological restoration is young enough that citizens can make real contributions to the knowledge of this discipline by carrying out restoration projects in the field. By carefully observing things like which plants seed in well, which are too aggressive, which need to be planted as plugs rather than by seed, what time of year is the best to plant for each species, and what plants will spring up when a woods is cleared and burned, anyone can add to the understanding of ecological restoration in their area.

Restoration science began in Madison in the 1940's at the University of Wisconsin Arboretum, where some of the very first ecological restoration in the world took place with the creation of the Curtis Prairie. It was here that the Society for Ecological Restoration was founded and began its scientific journal now titled "Ecological Restoration." The story of the growth of this restoration movement in the Upper Midwest was dramatic enough for New York Times science writer William Stevens to retell in the book "Miracle under the Oaks" (Stevens, 1995). Another Madison area pioneer was William Hilsenhoff who was one of the first in the U.S. to demonstrate that the identification and counting of aquatic insect orders and families could be directly correlated to the water quality of the stream from which the insect samples were collected (Hilsenhoff, 1982). This approach is now used by citizens who have learned to monitor water quality changes by collecting and sampling aquatic insects over time (WRM 1996, University of

Wisconsin – Extension 1998). This situation makes it all the more appropriate for a new state-owned, Madison area property to undertake large-scale restoration involving the local citizens and park visitors.

Natural Processes

Two components crucial to a healthy, diverse, and well functioning ecosystem are hydrology and disturbance regimes.

Hydrology

Issues central to restoration in the Nine Springs area will be to restore and maintain as much of the hydrologic regime as possible including removing drainage tiles and completely filling all drainage ditches using their associated spoil banks and other material as needed (Thompson & Luthin, 2000). Without restored hydrology, peat will dry up and shrubs and trees will invade (White, 1965) making restoration of sedge meadows and fens impossible. UW-Madison Hydrology professor Ken Potter and others (WDNR 2000b), strongly suggest using the current channelized streambed for Nine Springs Creek as storm water runoff, and directing the current spring flow and trout hatchery pond flow into the old meander channels of the former Nine Springs Creek.

Long-term preservation of the ground water supply will mean purchase or easements of land in the ground watershed to prevent development and maintain as much permanent vegetative cover as possible. Extensive use of rain gardens and small ponds in all developed areas will help increase ground water recharge.

Natural Disturbance Regimes

Disturbances include herbivory, fire, flood, and violent storms. These processes have created and kept our native plant communities in balance for thousands of years. In relatively constant environments, plants and animals adopting long-term survival strategies have a competitive advantage over those with short-term strategies. Conservative plant species take years to develop but then are very long lived. Large predators utilized vast expanses of similar habitats for a steady food supply, out-competing and often consuming meso-predators operating on the smaller scales. European settlement brought about very rapid changes in these processes, favoring annual and biennial plants over long lived conservative species through soil disturbance on a massive scale, fragmenting animal and plant migration corridors through the loss of wetlands and other habitats, and eliminating fire adapted species through the build up of duff, shrubs, trees, and soil nitrogen (Leach & Givnish, 1996).

Beaver *(Castor canadensis)*

Environmental Studies professor Cal DeWitt (see Contacts), as well as the WRM study (1996), suggest reintroduction of beaver. This would have the effect of creating many small ponds, which in most cases would drown out reed canary grass or box elder, and provide the same sorts of wetland functions as shallow and deep-water marshes. These ponds are good habitat for herons, ducks, egrets, and amphibians. Outwater (1996) gives a summary account of the history of beaver in North America and their positive effects on the hydrologic cycle and natural communities.

Fire

Most historical texts that discuss fire during the first half of the 19th century in southern Wisconsin stated that fire was an annual and usually autumnal occurrence (Curtis 1959, Muir 1913, Wernerehl 2001a,

2001b). Many studies discussed in Appendix B specifically stated that fire was a necessary component of the sedge meadow habitat, without which the meadows would rapidly disappear under a carpet of shrubs and then trees. Recent research in Wisconsin has established the importance of fire as a means to preserve many important, conservative prairie species (Leach and Givnish, 1996). Fire is an essential for the establishment of new prairie plantings. Annual fire is no longer considered essential or even desirable, yet occasional fire is clearly necessary to the establishment and maintenance of native ecosystems. Controlled fire in an urban environment is possible, requiring tighter prescriptions on wind and humidity to be successful.

Natural Communities

Restoration or reconstruction of native, natural communities involves study, inventory, and considerations of scale and landscape context in order to understand the ecological background of each plot of land to be restored. Other key elements include re-establishing hydrologic and natural disturbance regimes, removing invasives species, re-introduction of native species through seeds and plugs using local ecotypes, and monitoring the re-creations for successes, failures, and new and continuing threats. The term "restoration" is often used for the revivification of an existing, but degraded ecosystems. When a plant community is created from scratch, this is called reconstruction or re-creation.

Wetland

The first step in wetland restoration includes a thorough study of the history of the site, using old maps, photos, historical records, and air photos dating from 1937 and several more dates up to present. The second step in wetland restoration process includes restoring the hydrology (see above). Surveys should be done plotting six-inch contours to reestablish terrain and slope as close as possible to the original condition. Soil deposited from post-European settlement floods can often be a few inches to several feet deep. This should be measured, located, removed, and used to fill ditches. A third step is removing invasive species such as common reed (*Phragmites australis*) and reed canary grass. Reed canary grass monocultures can be rolled up by heavy equipment and placed into ditches. A fourth step is re-establishing native species. Often native seed banks still occur and will resprout once reed canary grass and post-settlement soils are removed. Many other issues regarding wetland restoration are explored in the recent WDNR publication "Wetland Restoration Handbook for Wisconsin Landowners" (Thompson & Luthin, 2000).

The value of wetland restoration is several fold. A well functioning wetland plays a major role in retaining rainwater, buffering floods, recharging groundwater, filtering sediment, and retaining nutrients. In the Capital Springs Centennial State Park and Recreation Area the wetland water flows into Nine Springs Creek and then directly into the Yahara River and on into Lake Waubesa. Thus, the pure water from a restored wetland up the watershed will directly affect the water quality at the swimming beach bound to be an essential part of the new state park. A restored wetland is a highly productive system, producing prodigious amounts of food for ducks, cranes, herons, and other birds that feed on frogs, fish, and insects, creating a direct benefit to duck hunters and bird watchers. Fish such as northern pike use wetlands to spawn. A restored Nine Springs Creek will allow them to venture far back into the marsh for spawning and increase predator fish populations in Lake Waubesa and Upper Mud Lake.

Prairie

There are four main steps in a new prairie re-creation: plan the project, prepare the soil, sow the seeds, mow, and burn. With a plan in place, kill off existing vegetation using herbicides and control the weeds

for a full growing season before planting. Once weeds are controlled, seeds can be planted with a seed drill or other type of seeder (a Brillion seeder works well) or hand scattered and dragged. Seeds must come in contact with bare soil. Fall seeding usually works best. Keep mowed firebreaks in place. An important part of establishing a prairie is mowing or haying during the first two growing seasons. Mow two or three times the first year, when growth reaches 18 to 24 inches, setting mower height six to eight inches. Mow once or twice more the second year. Haying, rather than simply mowing, helps by removing excess thatch that can smother young plants. Burn the site in the fall or spring after the first or second season through the fifth growing season, then as needed.

In the uplands, as the majority of land in the Capital Springs Centennial State Park is currently in crops, mesic prairie re-creation should be planned at a large scale with wet-mesic on a smaller scale. Crop fields are easier in many ways to work with, as weeds are already controlled. Some land should be continued to be cropped until a large enough seed source can be developed. In prairie reconstruction, the expertise of Dane County Naturalist Wayne Pauly should be utilized to begin this process. Mr. Pauly has restored hundreds of acres of prairie for Dane County Parks including some prairie in Lake Farm County Park, part of the planned CSCSP. Recent WDNR publications should be used to develop seed lists for local ecotypes seeds (Henderson 1998, Cochrane & Iltis 2000).

A prairie re-creation here on a large scale of 250 acres would be the largest native tallgrass prairie reconstruction in southern Wisconsin. Large size means it will likely be able to attract many area-sensitive grassland birds such as bobolink, Henslow's sparrow, grasshopper sparrow, savanna sparrow, sedge wren, harrier, short-eared owl, eastern and western meadowlark, Bell's vireo, and blue-winged teal. Many of these birds are state listed and have been decreasing in population for the last 40 years (Sample and Mossman, 1997). Ducks such as mallards and blue-winged teal often use large grasslands adjacent to water bodies for nesting, sometimes making their nests up to one half mile from the water. Prairie restorations are quite compatible with some other recreational activities. Beyond the bird breeding period of June and July, trails can cut through the prairie for hiking, skiing, mountain biking and horseback riding (perimeter trails can be used during June and July). Abundant and showy prairie flowers attract photographers as well as hummingbirds, migrating monarchs and other butterflies. A large prairie fire can be a tourist attraction when viewed from a distance. A prairie fire at night puts on a show more spectacular than most fireworks.

Oak Woodland and Oak Opening

Cheney & True (1892) found common oak opening and oak woodland plants in Dane County to be such species as shooting star, lupine, butterfly weed, New Jersey tea, prairie willow, Canada hawkweed, ox eye sunflower, Carolina vetch, and many others. These plants are very rare today due to much higher levels of shade (personal obs.). Cottam (1946) compared the Madison School Forest tree density and basal area to the presettlement oak openings described by the GLO surveyors in this same area. He found a 10-fold increase in density and an 8.4-fold increase in basal area. Tree species were similar but with a large increase in black cherry. Since Cottam's 1946 study, shade-tolerant species including red and sugar maple, basswood, box elder, ironwood and white ash have further increased forest densities, blocking out even more sunlight from the forest floor causing the loss of oak woodland plants not able to tolerant the dense shade cast by these newer canopy members of the oak forest (Henderson, unpublished).

Recent publications have shed more light on what had been a poorly understood community and should be consulted for a more in depth description of seed lists and restoration potential (Leach & Givnish 1998, 1999, Pruka 1995). Some woodland and savanna restoration is in process under the direction of Dane County Parks. This involves extensive clearing of all sub-canopy woody species in a stand of mature white oaks. Research ecologist Rich Henderson of the Wisconsin Department of Natural Resources

Bureau of Integrated Science Services is an expert on savanna vegetation and can be asked to supply seed lists and suggestions for restoration.

The value of oak woodland restoration lies in restoring a community that is rapidly disappearing from southern Wisconsin and with it the plants and animals dependent on this type of community to survive. Plants such as autumn coral root and yellow ladyslipper orchids, and birds such as redstart, redheaded woodpecker, blue-gray gnatcatcher, and wild turkey are some of the many organisms dependent on our oak woodlands. Due to patterns of European settlement and land use, intact oak openings in Wisconsin are one of the very rarest ecosystems in the entire world, occupying less than one one-hundredth of one percent of the original 5.5 million acres (WDNR 1995). This in itself indicates that restoring even a small part of such a quintessential southern Wisconsin ecosystem would be invaluable, both in its own right, and for educational purposes.

Opportunities for Interpretive Activities

Historical and Ecological Context

Prehistory to 1840 – Native Americans in Dane County

In thinking about indigenous ecosystems in and around the Capital Springs Centennial State Park and Recreation Area, the Native American inhabitants and their influence for the past 11,000 years should always be kept in mind. Pre-Columbian southern Wisconsin was filled with settlements of Native Americans (Birmingham & Eisenberg 2000, Birmingham & Rankin 1994, Mollenhoff 1982) who altered their environment primarily with fire and hunting, and to a small extent by cultivation of crops in river bottoms (Bonnicksen 2000). Their common and frequent use of fire created a very open landscape that is hard to imagine when looking at the dense forests and thick brush that often constitutes Dane County's woodlands and wetlands today (Wernerehl 2001a, 2001b).

After thousands of years this human influence resulted in the floristically rich, aesthetically appealing, and highly diverse landscape of prairie, savanna, open oak woodland, extensive sedge meadows and open marsh that the first European explorers and settlers found upon their arrival to the area. Those that left written records nearly always described this landscape as striking and appealing (Wernerehl 2001a, 2001b).

In 1766, Jonathan Carver described a large, well-established village of Sauk Indians at the northwest edge of Dane County as,

"…the largest and best village I ever saw. It contains 90 lodges, each large enough for several families… they grow great quantities of Indian corn, beans, melons &c. so that this place is esteemed the best market for traders to furnish themselves with provisions of any within 800 miles of it." (Carver, 1781)

Estimates of Native American populations in Wisconsin at the time of European contact are as high as 70,000 (Gartner, 1997). New European diseases such as measles and smallpox probably caused a great reduction of the numbers of native inhabitants. After seeing southwestern Wisconsin in 1852, the widely traveled geologist and naturalist David Dale Owen wrote,

"The whole combination suggests the idea, not of an aboriginal wilderness inhabited by savage tribes, but of a country under a high state of cultivation and suddenly deserted by its inhabitants." (Owen, 1852)

This drastic reduction of Native American populations in the 17th and 18th centuries led to decreasing fire frequency in the region, which caused a significant decrease in the extent of fire-dependant plant communities. Thus, the landscape visited by land surveyors in the mid-1800s was already impacted by European settlement. Plant ecologist John Curtis noted the significance of this fact in his 1959 book *The Vegetation of Wisconsin*: *"The vegetation as deduced from survey information, therefore, can be thought of as an intermediate stage in the transition from a prehistoric equilibrium between Indians and the land to the modern balance between white men and the land."* (Curtis 1959).

The Madison Area in the 1830's – A Landscape Description

Despite this depopulation of Native Americans, the tremendous fertility of the Madison lakes and wetlands attracted the Ho Chunk tribe, who, in the 1830's, had a large village on the northeast side of Lake Mendota near Fox Bluff and smaller villages at dozens of other locations. A fur trader estimated that the Ho Chunk raised 3,000 or more bushels of corn each year at their Four Lakes villages (Mollenhoff, 1982).

Juliette Kinzie, the wife of the Indian Agent at Fort Winnebago (near today's Portage), traveled with a party to Madison, then to Blue Mounds, in early March of 1831. In her text, she describes the land as almost entirely open prairie. She wrote a description as they left Madison:

"Our road, after leaving the lake, lay over a 'rolling prairie' now bare and desolate enough…Sometimes the elevations were covered with a thicket or copse, in which our dogs would generally rouse up one or more deer" (Kinzie, 1856).

William Rudolph Smith described the open character of the oak openings in the region:

"The groves surrounding, and interlacing, and sprinkling, and dotting the vast ocean of open field, can be threaded as easily with a carriage, as if you were driving through a plantation of fruit or forest trees, set or growing irregularly (Smith, 1838).

Simeon Mills walked into Madison in June of 1837 and described the land as,

"...a vast rolling prairie, broken here and there with groves and openings... At every step, at every turn, new and startling beauties came into view. The bur oaks stood out upon the hillsides like old orchards…" (Mollenhoff, 1982).

Landscape scale fire was common in the area up to the mid-1800s, when prairie fires were still reported on the isthmus of Madison. The Wisconsin State Journal published one account in 1870:

"...prairie fires coming down over the distant hills, on all sides toward the lakes afforded a spectacle for which one could dispense with all the circuses… that will ever be sent wandering among us. Twice we witnessed these fires cross the marshes through the woods over the University Hill and up through the town on the lower ground back of the city hall, firing the marshes on either side as they advanced" (from the Wisconsin State Journal February 4, 1870, as quoted in Mollenhoff, 1982).

A Land Rich in Game and Fish– Dane County 1845-1920

Madison area wetlands and lakes, including the Nine Springs Creek watershed and Lake Waubesa, were once highly productive ecosystems. In the early days in Madison, even the downtown area had a 172-acre marsh. In the spring when the marsh was flooded, fishermen in boats would make huge catches of fish with their spears (Mollenhoff, 1982). A French-Native American trapper set a net across the outlet of Lake Mendota every night and caught ten to 20 northern pike weighing from 20 to 40 pounds to sell to the settlers (Mollenhoff, 1982). H.A. Tenney came to Madison in 1845 and shot many prairie chickens and quail right on the Capitol Square. The lakes were described by other settlers as being, "fairly black in places with flocks of ducks and geese" (Mollenhoff, 1982). It was said that a hunter could load down a pony with game just by hunting from the Square out to Bascom Hill or to the Yahara River. In the 1870's, many of the local lakes had beds of wild rice and wild celery. Ho Chunk came every year to trap muskrat and mink in the marshes. Prairie chicken and quail were still abundant in all directions around the city

(Rowley, 1999). As late as the 1880—1890 period, it was common for a hunter to bag several dozen ducks between the three Madison lakes (Mendota, Monona, and Wingra) (Mollenhoff, 1982). Ho Chunk were still using a ancient, stone fish weir on the Yahara River just south of the study area, well into the 1900s (Barton, 1995).

In the late 1800s, wetlands faced three destructive forces: filling, draining, and peat mining. The last marsh near downtown Madison was not filled completely until 1920 (Mollenhoff, 1982). Two peat processing companies using peat mined from local wetlands operated shortly after the Civil War. Madison lakes had their own three-pronged threat: eutrophication from raw sewage dumping, siltation from crop field and construction site runoff, and the introduction of carp (Mollenhoff 1982, Rowley 1999). Bottom-feeding carp disrupt the shallow and deep-water marshes at the lakes' margins by excessively foraging of plants and greatly increasing the turbidity of the water (Volkert, 1999).

Upland Forests of Dane County Transformed: 1834-1946

Almost all of the present day forests of Dane County are derived from open oak savannas where fire was a common, often annual occurrence. Bur and white oaks have thick, fire resistant bark and are often undamaged by fire. Black and red oaks readily resprout if burned. The shade-tolerant, thin-barked maple, basswood, black cherry, ash, and ironwood are fire sensitive trees. The few places these trees survived were small areas located in fire-sheltered pockets on the northeast side of the larger lakes. Many observers noted the phenomenon of the savannas filling in quickly after fire suppression. John Muir described the changes in the 1850s around his home in Marquette County:

"As soon as the oak openings in our neighborhood were settled, and the farmers prevented running grassfires, the grubs grew up into trees, and formed tall thickets so dense that it was difficult to walk through them and every trace of the sunny openings vanished" (Muir, 1913).

University of Wisconsin plant ecologist Grant Cottam studied the Madison School Forest in 1946. He used the 1830's survey records for the rolling, timbered upland around the school forest to calculate the distance between trees and the number of trees per acre, comparing it to the values he found in the forest survey of 1946. Table 4 shows the result.

Table 4 Madison School Forest in 1834 and 1946

YEAR OF SAMPLE	**1834**	**1946**
Trees per Acre	14.3	143.0
Basal Area per Acre (square feet)	12.6	105.1

This almost ten-fold increase in forest density led to the disappearance of once common oak savanna plants such as shooting star, lupine, butterfly weed, New Jersey tea, prairie willow, Canada hawkweed, ox eye sunflower, Carolina vetch, and many others (Cheney & True, 1892).

Since Cottam's 1946 study, shade-tolerant species including red and sugar maple, basswood, box elder, ironwood, and white ash have further increased forest densities, blocking out even more sunlight from the forest floor. This is occurring all over southern Wisconsin and is causing the loss of oak woodland plants not able to tolerant the dense shade cast by these newer canopy members of the oak forest. Even the oak trees are no longer able to reproduce in this denser shade (Henderson, unpublished).

Other Resources for Educational and Interpretive Activities

Books and Publications

Many of the sources and references will provide high quality educational material for a future state park naturalist to use at Capital Springs Centennial State Park and Recreation Area.

Kinney, Thomas P. 1993. *Irish Settlers of Fitchburg, Wisconsin 1840-1860*. Fitchburg Historical Society. 122 pp. This book is an excellent local history that covers the greater Nine Springs area quite well, it features historic and new photographs as well as old plat maps and many other images.

The most recent summary of Dane County geology is the1997 book and map entitled *Pleistocene Geology of Dane County*, Wisconsin by Lee Clayton and John W. Attig, Wisconsin Geological and Natural History Survey Bulletin 95.

Volkert (1999) offers a classic, short environmental history of a large marsh in southern Wisconsin that faces some of the same challenges and opportunities as this study area (see also contacts).

Additional publications include the *Water Action Volunteers Make WAVes for Action: Introductory, Hands-On Stream and River Action Projects for Wisconsin*. UW-Extension Publication GWQ018. 630 W. Mifflin St. Madison, WI 53703. Phone: 262-3346. This is also a Wisconsin Department of Natural Resources Publication PUBN-WT-388-98.

Contacts

Madison Audubon Society – 222 S. Hamilton St. Madison, WI 53703. Phone: 255-2473 Email: masoffice@mailbag.com. Madison Audubon is a very active chapter of the National Audubon Society and has field trips at several locations in the Capital Springs Centennial State Park and Recreation Area.

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William Volkert – Naturalist and Wildlife Educator, Wisconsin Department of Natural Resources, N7725 State Hwy. 28, Horicon, WI 53032. (see Volkert, 1999).

Conclusion

Capital Springs Centennial State Park and Recreation Area does indeed contain some jewels within a dense, urban population. Sparkling springs, stately oaks, sora rails, and diverse sedges remain after decades of development on the outskirts of this 3000-acre green space. Clear opportunities exist for public education, interpretation, and restoration. Restoration provides further opportunities for community and visitor involvement.

The majority of the native biological systems within the Capital Springs Centennial State Park and Recreation Area are compromised and threatened. Hydrologic threats come from rapid urban development and from existing drainage ditches and tiling within the wetlands. A second threat comes from invasive species, predominantly reed canary grass, that has taken over a large percentage of the wetlands. A third threat comes from invading shrubs and trees, both native and non-native, that are able to take advantage of the altered hydrology and long standing fire suppression..

Despite the threats to the system, there are still areas of high quality plant communities within the watershed, as well as unexplored areas that have not been well documented.

Recommendations for Future Inventory

Birds

The Wisconsin Breeding Bird Atlas at the University of Wisconsin-Green Bay Department of Natural and Applied Sciences was queried. The database was developed with breeding bird searches using “quad” maps, a “quad” (short for quadrangle) in this case is a 7.5-minute series USGS (United States Geological Survey) topographic map. The Madison East Quad covers the entire eastern half of the study area. The data confirmed a Least Bittern breeding as well as Dickcissel, both Special Concern (S3B) species Local ecologist Elizabeth Zimmerman could be consulted regarding Least Bittern populations. She has conducted breeding surveys in the area for the Least Bittern. Dickcissels are passerine birds of very open grasslands and do not regularly use the same breeding territory from year to year. They could be expected to be found occasionally in the eastern part of the study area. The MMSD lagoons should continue to provide interesting and rare migrants, whose population is regularly noted on the Madison Audubon Society’s bird hotline (see contacts).

Plants

Additional systematic plant survey work in the nine survey sites will almost certainly turn up listed species that require wetland habitat, especially after controlled burns. Table 5 shows plant species that should be sought in the study area. Two of the species are federally listed as threatened, the prairie white-fringed orchid and the prairie bush clover. Site 8 should be explored further for *Carex suberecta*. This is in the Carex section Ovales, a very difficult taxonomic group. Andrew Hipp, a local graduate student is working on this Carex section and should be asked to explore the area for this species. A recent key to the section in Indiana was just published in The Michigan Botanist (2000).

Table 5 Rare plants with a good potential for occurring in the study area

Scientific Name	Common Name	Srank	State Status	Where to search
Agastache nepetoides	Yellow giant hyssop	S2	THR	This is likely to pop up with clearing and burning in woodlands.
Asclepias purpurascens	Purple milkweed	S2	END	Potential drumlin prairie remnant. Site 9.
Calamagrostis stricta	Slim-stem small-reedgrass	S3	SC	Good sedge meadows such as sites 1 and 5.
Callitriche heterophylla	Large water-starwort	S2	THR	Ponds and shallow streams.
Cardamine pratensis	Cuckooflower	S3	SC	Sedge mats within emergent marshes, Sites 6 through 8
Carex suberecta	Prairie straw sedge	S1	SC	Reported in 1986 in site 8.
Cypripedium candidum	Small white lady's-slipper	S3	THR	Sedge meadows, especially after a burn, sites 1, 2, 3, & 5.
Cypripedium parviflorum	Small yellow lady's-slipper	S2S3	SC	A fen associate, old tamarack swamps and borders of wet woods, especially after a burn. Sites 1, 2, 3, & 8.
Cypripedium reginae	Showy lady's-slipper	S2S3	SC	A fen associate. Sites 1, 2, 3, & 8.
Eleocharis engelmannii	Engelmann spike-rush	S2	SC	Ponds, banks, exposed mud.
Gentiana alba	Yellow gentian	S2	THR	Often appears at woodland edges with clearing and burning.
Gentianopsis procera	Lesser fringed gentian	S3	SC	A fen associate. Sites 1, 2, 3, & 8
Lespedeza leptostachya	Prairie bush-clover	S1	END	Potential drumlin prairie remnant. Site 9.
Ophioglossum pusillum	Adder's-tongue	S3	SC	Sedge meadows, former hay meadows, Sites 1, 2, 3, & 5.
Orobanche uniflora	One-flowered broomrape	S3	SC	May occur in woodlands undergoing restoration.
Platanthera leucophaea	Prairie white-fringed orchid	S1	END	Sometimes appears after fire in wet prairies and sedge meadows or when shallow wetland scrapes are created. Only likely to occur if hydrology is restored.
Polytaenia nuttallii	Prairie parsley	S2	THR	Potential drumlin prairie remnant. Site 9.
Potamogeton vaginatus	Sheathed pondweed	S1	THR	Upper Mud Lake, Lake Waubesa or possibly Nine Springs Creek
Psoralea esculenta	Pomme-de-prairie	S3	SC	Potential drumlin prairie remnant. Site 9.
Scirpus cespitosus var callosus	Tussock bulrush	S2S3	END	A fen associate. Sites 1, 2, 3, & 8
Silene nivea	Snowy campion	S2	THR	A fen associate. Sites 1, 2, 3, & 8
Triglochin maritima	Common bog arrow-grass	S3	SC	A fen associate. Sites 1, 2, 3, & 8
Triglochin palustre	Slender bog arrow-grass	S3	SC	A fen associate. Sites 1, 2, 3, & 8

Sources and References

Arnold, Jennifer, S. Folk, E. Kurtz, S. Rick, J. Senlon, and T. Trinko. 1999. *A Vegetation Survey Of Nine Springs: Describing The Diversity Of Native Communities*. Student paper for UW-Madison Field Ecology 375. 22 pp.

Barton, David F. 1995. *The Dyreson Fish Weir on the Yahara River*. Yahara Watershed Journal 1:14-16

Bedford, Barbara L., J. H. Zimmerman & E. H. Zimmerman. 1974. *The Wetlands of Dane County, Wisconsin*. Dane Co. Regional Planning Commission. 593 pp.

Birmingham, Robert A. & Leslie E. Eisenberg. 2000. *Indian Mounds of Wisconsin*. University of Wisconsin Press, Madison. 262 pp.

Birmingham, Robert A & Katherine H. Rankin. 1994. *Native American Mounds in Madison and Dane County*. City of Madison Dept. of Planning & Development. 20 pages w/map.

Bradbury, K. R. , M. A. Muldoon, A. Klein, D. Misky, M. Strobel. 1995. *Water Table Map of Dane County* (Open file report 95-1). Wisconsin Geological and Natural History Survey.

Bonnicksen, Thomas M. 2000. *America's Ancient Forests: From The Ice Age To The Age Of Discovery.* John Wiley & Sons. (see chapter on fire)

Burcar, Kay. Undated. *Birds of the Nine Springs E-Way*. Dane County Parks, Madison Audubon Society. Brochure and checklist.

Cahn, A. R. 1916. *An Ecological Survey of the Wingra Springs Region.* Bulletin of the Wisconsin Natural History Society 13(30):123-177.

Calloway, Colin G. 1997. *New Worlds for All: Indians, Europeans, and the Remaking of Early America.* John Hopkins University Press. 235 pp.

Carpenter, Quentin. 1995. *Toward a New Definition of Calcareous Fen for Wisconsin*. Ph.D. Dissertation, University of Wisconsin – Madison.

Carver, Jonathan. 1781. *Travels through the Interior Parts of North America*. London. in Gelb, Norman, editor, 1993, *Jonathan Carver's Travels Through America, 1766-1768.* John Wiley & Sons. 252 pp.

Cheney , L. S. & R. H. True. 1892. *Flora of Madison and Vicinity*. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 9:45-135.

Clayton, Lee and John W. Attig. 1997. *Pleistocene Geology of Dane County, Wisconsin.* Wisconsin Geological and Natural History Survey Bulletin 95 (book & map). Used by permission.

Cochrane, Theodore S. 1999. *Preliminary Report on the Madison Area E-Way Fens*. Personal communication dated June 4, 1999. 2 pp.

Cochrane, Theodore S. and Hugh H. Iltis. 2000. *Atlas of the Wisconsin Prairie and Savanna Flora.* Wisconsin Department of Natural Resources Technical Bulletin #191. 229 pp.

Costello, D. F. 1936. *Tussock Meadows in Southeastern Wisconsin.* Botanical Gazette *97:610-49*

Cottam, Grant. 1949. *The Phytosociology Of An Oak Woods In Southwestern Wisconsin*. Ecology 30(3):271-287.

Curtis, John T. 1959. *The Vegetation of Wisconsin*. University of Wisconsin Press, Madison, WI. 657 pp.

Dane County Regional Planning Commission. 1995. *General land use plan: City of Fitchburg, Wisconsin, March 1995*. Fitchburg, Wisconsin: Dane County Regional Planning Commission.

Ellarson, Robert S. 1949. *The Vegetation of Dane County Wisconsin in 1835*. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 39:21-45.

Featherstonhaugh. 1847, *A Canoe Voyage Up the Minnay Sotor*. Reprinted by Minnesota Historical Soc., 1970. (Quoted in The Passenger Pigeon, Vol. 50, pg. 320)

Frolik, A.L. 1941. *Vegetation of the Peat Lands of Dane County, Wisconsin*. Ecological Monographs 11:117-140.

Gartner, William G., 1997, *Four Worlds Without an Eden: Pre-Columbian Peoples and the Wisconsin Landscape.* in Robert C. Ostergren and Thomas R. Vale, editors. "Wisconsin Land and Life," University of Wisconsin Press. 580 pp.

Hansen, B.F. 1975. *Natural Areas Inventory of Nine 'Springs Valley Environmental Corridor*. University of Wisconsin-Madison Arboretum.

Henderson, Richard A. unpublished data. *Olson Oak Woods Study*. Wisconsin Department of Natural Resources - Integrated Science Services.

Henderson, Richard A. 1998 *Plant Species Composition of Wisconsin Prairies.* Wisconsin Department of Natural Resources Technical Bulletin #188. 63 pp.

Henderson, Rich. 2001. Personal communication. Wisconsin Department of Natural Resources - Integrated Science Services, 1350 Femrite Drive, Madison, WI, 53716.

Hilsenhoff, William L. 1982. *Using a Biotic Index to Evaluate Water Quality in Streams.* Wisconsin Department of Natural Resources Technical Bulletin #132. 22 pp.

Kearns, S. Kelly. 2002. Personal communication. Wisconsin Department of Natural Resources - Bureau of Endangered Resources. P.O. Box 7921, Madison, WI, 53703.

Kinney, Thomas P. 1993. *Irish Settlers of Fitchburg, Wisconsin 1840-1860*. Fitchburg Historical Society. 122 pp.

Kinzie, Juliette M. 1856. *Wau-bun, The "Early Day" in the North-West*. Derby, New York. Republished by University of Illinois Press, 1992, pg. 74 & 78.

Leach, Mark K and Thomas J. Givnish, 1996. *Ecological determinants of species loss in remnant prairies.* Science 273:1555-1558

Leach, Mark K and Thomas J. Givnish. 1998. *Identifying Highly Restorable Savanna Remnants.* Transactions of the Wisconsin Academy of Sciences, Arts and Letters 86:119-127

Leach, Mark K and Thomas J. Givnish, 1999. *Gradients in the Composition, Structure, and Diversity of Remnant Oak Savannas in Southern Wisconsin.* Ecological Monographs Vol. 69 #3:353-374

Madison Metropolitan Sewerage District, Dane County Parks, Madison Audubon Society. 2001. *Birds of the MMSD Wildlife Observation Area.* Brochure and checklist.

Mollenhoff, David V. 1982. *Madison, A History of the Formative Years*. Kendall/Hunt, Dubuque, IA. 500 pp.

Mossman, Michael J. and David Sample. 1990. *Birds of Wisconsin Sedge Meadows*. The Passenger Pigeon 52(1): 38-55.

Muir, John. 1913. T*he Story of My Boyhood and Youth*. Republished by University of Wisconsin Press, 1965. (Quoted in The Passenger Pigeon 50 (2):156)

Novitzki, R. P. 1978. *Hydrology of the Nevin Wetland near Madison, Wisconsin.* U.S. Geological Survey Water Resources Investigation 78-48.

Nurre, Rob. 2002. General Land Office Public Land Survey, Wisconsin Board of Commissioners of Public Lands, Madison, Wisconsin 53708-8943. This office houses digitized and original records.

Olcott, P. G. 1973. *Bedrock Topography of Dane County, Wisconsin***.** Wisconsin Geological and Natural History Survey, unpublished map. (in Novitzki, 1978).

Outwater, Alice B. 1996 *Water: A Natural History*. BasicBooks, New York, New York. 224 pp.

Owen, Catherine R. 1995. *Water budget and flow patterns in an urban wetland*. Journal of Hydrology 169:171-187

Owen, Catherine R., Q. J. Carpenter, C. B. DeWitt. 1989. *Evaluation of Three Wetland Restorations Associated with Highway Projects.* Transportation Policy Studies Institute, Wisconsin Department of Transportation. 94 pp.

Owen, David Dale. 1852. *Report of a Geological Survey of Wisconsin, Iowa and Minnesota; and Incidentally of a Portion of Nebraska Territory*. Philadelphia, pg. 66. As quoted in Gartner, 1997.

Park, W. J. & Co editors. 1877. *Madison, Dane County And Surrounding Towns*. Wm. J. Park & Co. Madison, WI, 664 pp. (Reprinted in 1977 by Dane Co. Historical Society)

Pruka, B. W. 1995. *Lists Indicate Recoverable Oak Savannas and Open Oak Woodlands in Southern Wisconsin.* Restoration and Management Notes 13(1):124-26

Rothrock, Paul E., A. A. Reznicek. 2000. *Taxonomy, Ecology, and Biogeography of Carex section Ovales in Indiana.* The Michigan Botanist 39(2):19-37.

Rowley, Leslie Brooks. 1999. *Lake Wingra in the 1870s*. The Yahara Watershed Journal 3:2-4

Sample, David W. and M. J. Mossman. 1997. *Managing Habitat for Grassland Birds: A Guide for Wisconsin*. Wisconsin Department of Natural Resources, Integrated Science Services. 160 pp.

Schmitt, Tom and P. Voss. 1997. *Vegetation and Hydrologic Conditions of the Syene Road Fen*. Student paper of UW-Madison IES 361. 13 pp.

Smith, William Rudolph. 1838. *Observations of the Wisconsin Territory*. E.L. Carey & A. Hart Philadelphia. Reprinted by Arno Press, 1975, New York.

State of Wisconsin Blue Book 2001—2002. http://www.legis.state.wi.us/lrb/bb/ch8j.pdf (search May 2002).

Stevens, William K. 1995. *Miracle Under the Oaks: The Revival of Nature in America*. Simon and Schuster, New York. 340 pp.

Stout, A.B. 1914. *A Biological And Statistical Analysis Of The Vegetation Of A Typical Wild Hay Meadow*. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 17:405-469.

Swink, Floyd and Gerould Wilhelm. 1994. *Plants of the Chicago Region*. 4th edition. Indiana Academy of Science, Indianapolis. 935 pp.

Thompson, Alice and C. S. Luthin. 2000. *Wetland Restoration Handbook for Wisconsin Landowners*. Wisconsin Department of Natural Resources - Integrated Science Services. 122 pp.

Vogl, Richard J. 1969. *One Hundred And Thirty Years Of Plant Succession In A Southeastern Wisconsin Lowland*. Ecology 50:248-255.

Volkert, William K. 1999. *Wetland Habitats and Their Ecology: The Horicon Marsh Case History*. The Passenger Pigeon 61(3):355-369.

U.S. Census Bureau. 2002. http://quickfacts.census.gov/qfd/states/55/55025.html (search May 2002).

University of Wisconsin – Extension. 1998. *Water Action Volunteers Make WAVes for Action: Introductory, Hands-On Stream and River Action Projects for Wisconsin*. UW-Extension Publication GWQ018. (Wisconsin Department of Natural Resources Publication PUBN-WT-388-98.)

University of Wisconsin – Madison Department of Geology & Geophysics. 2002. Quaternary Research Group. http://www.geology.wisc.edu/~qlab/ (search April 2002).

Wang, L., J. Lyons, P. Kanehl, and R. Gatti. 1997. *Influences of Watershed Land Use on Habitat Quality and Biotic Integrity in Wisconsin Streams.* Fisheries 22 (6):6-12.

Water Resources Management Practicum. 1996. *Nine Springs Watershed And Environmental Corridor : A Water Resources Management Study*. Institute for Environmental Studies, University of Wisconsin-Madison. 204 pp.

Wernerehl, Robert W. 2001a. *Historical Background of the Blue Mounds Region*. The Blue Mounds Area Project (newsletter) 4(3):3-4.

Wernerehl, Robert W. 2001b. *Historical Background of the Blue Mounds Region: Part Two*. The Blue Mounds Area Project (newsletter) 4(4):3-4

White, K.L. 1965. *Shrub Carrs of Southeastern Wisconsin*. Ecology 46:286:303.

Wisconsin Department of Natural Resources. 1995. *Wisconsin's Biodiversity as a Management Issue: A Report to the Department of Natural Resources Managers.* 240 pp.

Wisconsin Department of Natural Resources. 1999. *Biotic Overview Report – Nevin Fish Hatchery Property Master Plan*. Bureau of Endangered Resources – NHI Program. 23pp.

Wisconsin Department of Natural Resources. 2000a. *Governor announces two Centennial State Parks* DNR News Release Oct. 31, 2000. http://www.dnr.state.wi.us/org/caer/ce/news/rbnews/2000/001031co.htm (searched April 2002).

Wisconsin Department of Natural Resources. 2000b. *Nevin Springs Fish and Wildlife Area Master Plan*. 90 pp.

Wisconsin Department of Natural Resources. 2000c. *Wisconsin Natural Heritage Working List*. Bureau of Endangered Resources. Version of October, 2000.

Zimmerman, James H. 1983. *The Revegetation Of A Small Yahara Valley Prairie Fen.* Transactions of the Wisconsin Academy of Sciences, Arts and Letters 71(2):87-102.

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phone (608) 263-7771 phone2 (608) 263-5481
Dr. Carpenter is an expert on fens (see Carpenter, 1995).

John Jackson – Wis. Department of Transportation – Biologist/Ecologist
Phone: 267-7777 Fax: 266-7818 Email: john.jackson@dot.state.wi.us
John did work on wetland restoration for the south beltline and has sent a study that includes good botanical information on Upper Mud Lake marsh.

John Lyons. Watershed Ecologist, Wisconsin Department of Natural Resources, Integrated Science Services. Phone: 221-6328 Email: lyonsj@dnr.state.wi.us

Wayne Pauly – Dane County Parks Naturalist
Phone 224-3603 Cell Phone 575-0396
He has a large file of material about the Nine Springs E-way.

Dave Sample - Grassland Bird Ecologist, Wisconsin Department of Natural Resources, Integrated Science Services. Email: sampld@dnr.state.wi.us Co-Author of a paper *Birds of Wisconsin Sedge Meadows*. He said that none of the areas surveyed were in the study area.

Reed Canary Grass

Tom Bernthal – Wetland Specialist, Wisconsin Department of Natural Resources
Phone: 266-3033 Email: berntt@dnr.state.wi.us Working on reed canary grass study with Kevin Willis using Landsat 7 (satellite data (path 24, row 30) from October 15, 1999) imagery to locate solid stands of reed canary grass (RCG) in a 180 kilometer square area of southern Wisconsin.

Kevin Willis - Wisconsin Department of Natural Resources Bureau of Parks
Phone: 261-4933 Email: willik@dnr.state.wi.us
Reed canary grass study. See above.

Cal DeWitt –IES professor at UW – Madison
Phone: 265-2564 Email: cbdewitt@facstaff.wisc.edu
Professor De Witt has done considerable research at Waubesa Wetlands, just south of the site. Conversation 29 April 02. He did not know for certain of any readily accessible plant lists for Lake Waubesa, although many undergrad student papers had such lists. For the Monona Conservancy wetlands he recommended Sharon Ashworth's 1997 paper in Wetlands 17:518-527. This same material is covered by Owen, et. al. 1989.

Eileen M Kirsch - USGS WILDLIFE BIOLOGIST (RESEARCH)
address: 2630 Fanta Reed Road, LaCrosse, WI 54603
phone: 608-781-6226 fax: 608-783-6066 Email: eileen_kirsch@usgs.gov
Eileen presented a study of birds and reed canary grass at the Wetlands conference 1 Feb. 2002 in Fond du Lac and has emailed a copy to us.

Joy Zedler – UW–Madison. Professor of Botany and Restoration.
Phone: 262-8629 Email: jbzedler@facstaff.wisc.edu She has had grad students working on the problem of reed canary grass. None of them worked in the Nine Springs area, although they did work just upstream around Dunn's Marsh and the UW Arboretum. Here 4 grad students that have finished theses are Katie Werner, Debbie Maurer, Vicki Miller (all masters theses) and Roberto Lindig-Cisneros (PhD). These can all be viewed in the library.

Property Planners, Administrators

Wisconsin Department of Natural Resources

Michele Chalice - Senior landscape architect and property planner. 3711 Fish Hatchery Road, Fitchburg, WI Phone: 275-7773 Fax: 275-3338 Email: chalim@dnr.state.wi.us

Dana White Quam - Parks & Recreation Expert - South Central Region

Phone: 275-3302 Email: whiteD@dnr.state.wi.uw

Drew Feldkirchner - Inventory Planner**,** Endangered Resources Program
PO Box 7921, Madison, WI 53707-7921
Phone: 608-267-5129 Email: feldkd@dnr.state.wi.us
Oversees this study and provided a copy of the Nevin Springs Biotic Assessment done by BER in 1999.

Joanne Tooley- GIS.
Phone 261-6418

Dane County Parks – Phone 246-3899

Chris James – Parks Planner
Phone: 242-4586. Has some property boundary information.

Ken LePine – Parks Director
Phone: 246-3895

Local History

Michael Bovre, Dane Co. Historical Society President. Phone: 277-1119

Tim Heggland – Historical researcher, mostly architectural. Phone: 795-2650. Helped with *Back to the Beginnings*, an early history of Dane County..

Robb Nurre: *General Land Office Public Land Survey* (1830-1840). Wisconsin Board of Commissioners of Public Lands, Madison, Wisconsin 53708-8943. Phone: 261-8841. This office houses digitized and original records. Rob is an expert on this information, both on the records themselves and on the chief surveyors.

Appendices

Appendix A: Hydrology – Basic Concepts

There are three important concepts to understanding the hydrology of south central Wisconsin. One is the distinction between what is normally called the *watershed* and the *ground watershed*. To the hydrologist, the watershed is divided into two areas. The *surface watershed* is the boundary inside of which all surface water drains to a central stream, river, lake, or wetland. The *ground watershed* is the boundary inside of which all groundwater drains into a central wetland, stream, lake, or aquifer.

Hydrology is similar to a balance sheet. Water enters a watershed through precipitation and leaves through runoff and evapotranspiration. If the input is greater than the output, springs or seeps form to discharge the extra water.

However, a change in the ratio between *impervious* surfaces, such as pavement and rooftops, and *permeable* surfaces such as grasslands, crop fields and forests, can dramatically alter this balance. The higher the ratio, the lower the amount of groundwater recharge. Impervious surfaces shed water into storm sewers and cause a very rapid rise and consequent fall of local stream levels. Surface runoff carries pollutants and excess nutrients into the streams as well. In contrast, permeable surfaces allow the water to percolate into the soil where, during the growing season, much of it is taken up by plants and returned to the air via evapotranspiration from leaf surfaces. During the remainder of the year most of the water on permeable surfaces travels below the soil and recharges the groundwater aquifer. The soil particles absorb many of the pollutants and nutrients the water may be carrying . This groundwater can then seep out and feed streams with an even flow of cool water, or soak into peat-based wetlands keeping water dependent plants and animals thriving and resisting the invasion of shrubs, trees and reed canary grass.

Appendix B:
Surveys and Scientific Papers Relevant to the Study Area

A variety of organizations and individuals have conducted surveys within the Nevin Fish Hatchery study area and surrounding Nine Springs E-Way. Surveys were conducted between from 1974 and 1995 and cover terrestrial and aquatic level surveys.

General Studies of the Ecology of the CSCRA

Nine Springs Watershed and Environmental Corridor: A Water Resources Management Study
Prepared by the Water Resources Management Practicum (WRM) for the Institute for Environmental Studies at the University of Wisconsin-Madison in 1996, this study covered a variety of ecological attributes, including soil, surface water, macro-invertebrates, vegetation, and fish sampling. Detailed survey methodology is provided in the text. Natural community and vegetation field investigations were limited to areas classified as relatively non-degraded by Bedford in 1974.

Aquatic macro-invertebrate surveys completed by WRM included two spring areas as sampling sites due to the presence of spring water, high dissolved oxygen, and the high probability for these locations to support significant macro-invertebrate communities. Sampling dates and methodologies are included in the text.

Fish sampling was conducted by WRM at three locations within Nine Springs Creek. On June 25, 1996, two samples were taken, using a haul seine (bag net mesh size 0.2-inches) at Nursery Springs near the fish hatchery, and the Moorland Road crossing of Nine Springs Creek. These sites were chosen in order to target fish species associated with the physical characteristics of the creek at these locations. Moorland Road was chosen to target warm water species, and Nursery Springs to target cold-water species.

Distribution and Abundance of Fishes in Wisconsin: Greater Rock River Basin (WDNR Technical Bulletin No. 136)

Additional fish sampling was conducted in 1982 by D. Fago of WDNR-Bureau of Integrated Science Services, as part of the statewide survey of the distribution and abundance of fishes in Wisconsin. Sampling was conducted at only one site: Moorland Road on Nine Springs Creek.

Bureau of Endangered Resources (BER) Survey of 1997

Identification of survey sites within the study area was completed in August of 1997 and involved analysis and interpretation of topography and vegetation, employing topographic maps and aerial photographs. Additional information was gathered from the past studies described above.

Field surveys completed by BER in 1997 involved natural community types and informal bird surveys. Brief natural community surveys were completed on August 20 and 27, 1997 on property owned by WDNR, Nine Springs County Park, Wisconsin Alumni Research Association, Fitchburg Center, and multiple private owners (6N 9E sections 3, 10, 11 (2,1)). The sedge meadow located at the northern portion of the Nevin Wetlands near the WISC radio towers (6N 9E section 2) was surveyed on September 29, 1997. The vegetation cover type map (Figure 1) was compiled from these field surveys and the findings of Hansen (1975). On August 27, 1997, an informal bird survey was completed within the Nevin Wetlands, by BER community ecologist Eric Epstein. No field surveys for rare plant or aquatic macro-invertebrate species were completed within the study area by BER staff.

Vegetation

Arnold, J., S. Folk, E. Kurtz, S. Rick, J. Senlon, and T. Trinko. 1999. *A Vegetation Survey Of Nine Springs: Describing The Diversity Of Native Communities.* Student paper for UW-Madison Field Ecology 375. 22 pp.

> This paper has excellent plant lists and maps and covers a very small area of the Nine Springs E-way. Some fen species were found including *Carex sterilis*. Some plants were identified by Ted Cochrane, curator of the UW-Madison herbarium and an expert on the genus *Carex*. The maps are small and detailed but not well geo-referenced.

Bedford, B.L., J.H. Zimmerman & E.H. Zimmerman. 1974. *The Wetlands of Dane County, Wisconsin*. Dane Co. Regional Planning Commission. 593 pp.

> Bedford conducted a brief survey of the vegetation of the Nine Springs Creek wetlands and Upper Mud Lake wetlands and included a detailed map of vegetation types. All of their mapping was based on a detailed map by Arlyn Linde done for the Wisconsin Department of Natural Resources in 1973.

This map could not be located. It was apparently stored at the southern district headquarters at the time of a fire in the building, and may have been destroyed. The surveys include vegetation and community types. Methods are detailed in the text. They found sedge meadow, emergent aquatic and Tamarack (rich) Swamp communities. No plant lists were given. The area around Upper Mud Lake often contains the note, "not examined in detail" which meant only using air photos and binoculars.

Bernthal, Tom and Kevin Willis, 2002 unpublished.

The authors (both of the WDNR) using Landsat 7 (satellite) imagery from October 15, 1999 to locate solid stands of reed canary grass (RCG) in a 180 kilometer square area of southern Wisconsin. They focused in on Nine Springs E-way as a test site. They labeled three classes: 1) monoculture dominated by RCG, 85 percent coverage or greater. 2) mixed – 50-80 percent RCG, 3) other. They then field checked their data for accuracy. The study is not yet published and the authors request it be clearly stated they are still in the error checking stage. Maps of preliminary findings make a visual impact and show that reed canary grass is a serious issue in the CSCRA.

Cochrane, T. S. 1999. *Preliminary Report on the Madison Area E-Way Fens*. Personal communication dated June 4, 1999. 2 pp.

Ted Cochrane is curator of the UW-Madison herbarium and an expert on the genus *Carex*. This describes a very brief survey of an area in the E-Way along the Capital City bike trail. In a very short time some good fen plants were found. Descriptions and the sites and short plant lists are given.

Hansen, B.F. 1975. *Natural Areas Inventory of Nine Springs Valley Environmental Corridor*. University of Wisconsin-Madison Arboretum.

This inventory was conducted for the University of Wisconsin-Madison Arboretum as part of the study of the environmental corridor (E-Way). This covered all of the study area east to Lake Waubesa, but did not cover the Monona Conservancy or Upper Mud Lake wetlands. Upland areas were covered. Although Hansen does list many plants by scientific name, the study does not give methods, and is no doubt made from a one-time walk through of the property. Lists for the richer sedge meadow areas are quite limited. No high quality upland areas were found. A difficulty with this study is that the location of each area is tied to maps that are not supplied, and to old property names that are out of date. The most relevant findings are reiterated in the Nevin Fish Hatchery Biotic Overview (WDNR, 1999).

Owen, C.R., Q. J. Carpenter, C.B. DeWitt. 1989. *Evaluation of Three Wetland Restorations Associated with Highway Projects.* Transportation Policy Studies Institute, Wisconsin Department of Transportation. 94 pp.

This study looked at the Monona Conservancy and Upper Mud Lake Wetlands prior to and after the building of the South Beltline across the marsh and Yahara river. Detailed plant lists are given showing a rich assemblage of emergent aquatic and sedge meadow species. The most interesting finding is of *Carex suberecta*, a state special concern species with an S1 ranking (very rare, 5 or fewer occurrences statewide). Further information is available from DOT Biologist John Jackson (see Contacts).

Schmitt, T. and P. Voss. 1997. *Vegetation and Hydrologic Conditions of the Syene Road Fen.* Student paper of UW-Madison IES 361. 13 pp.

This paper has a limited plant list but has excellent maps and air photos and some good soils and hydrology information. It compares air photos from 1980 and 1990 that show a startling and dramatic invasion of shrubs. The invasion of shrubs corresponded to a sharp increase in nearby development and impervious surfaces.

Water Resources Management Practicum. 1996. *Nine Springs Watershed And Environmental Corridor : A Water Resources Management Study*. Institute for Environmental Studies, University of Wisconsin-Madison. 204 pp.

This study found that some quality sedge meadow, as well as two areas of calcareous fen, still existed near the Nevin Fish Hatchery property. It cited unpublished student papers in part to support this finding. The study also concluded that within the E-Way, non-degraded wetland vegetation has shrunk by approximately 70 percent since 1974! Much of the results are summarized in the Nevin Fish Hatchery Biotic Overview (WDNR-BER 1999).

Studies of Sedge Meadows and Calcareous Fens in or Near Dane County

It should be noted that although many of these studies are old and might be considered out of date, some are very well done and give valuable keys to conditions much closer to those prior to European settlement.

Costello, D. F. 1936. *Tussock Meadows in Southeastern Wisconsin.* Botanical Gazette *97:610-49.*

This study gave a full plant species list and a list by quadrat frequency. It discusses the effects of draining, fire, and grazing on successional trends.

Frolik, A.L. 1941. Vegetation of the Peat Lands of Dane County, Wisconsin. Ecological Monographs 11:117-140.

This study listed species by quadrat frequency and presence, including wet prairie. It also gives an interesting table of 18 wetland drainage projects in Dane Co. from 1901 to 1926 totaling 45,000 acres, 40 percent of the peat based wetlands. Nine Springs Creek was listed as a drainage project from 1906-1910 as 1,400 acres.

Stout, A.B. 1914. *A Biological And Statistical Analysis Of The Vegetation Of A Typical Wild Hay Meadow*. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 17:405-469.

This study took place just north of where the Alliant Center (former Dane County Coliseum) is today, perhaps a mile from the closest land in the CSCRA. This took a very detailed and labor intensive approach and counted stems in 3,450 4-inch square quadrats across a sedge meadow. It lists frequency by occurrence and also gives dry biomass for the most common species. This sort of labor intensive study is quite uncommon today due to limited funding generally given for basic plant community research. The plant list from this study should be considered valuable in restoration projects, although the nomenclature will need to be updated.

Vogl, R. J. 1969. *One Hundred And Thirty Years Of Plant Succession In A Southeastern Wisconsin Lowland*. Ecology 50:248-255.

This study is a very good environmental history of a marsh in Jefferson County. It details fire effects on presettlement vegetation and discusses succession.

White, K.L. 1965. *Shrub Carrs of Southeastern Wisconsin*. Ecology 46:286:303.

This study examined 175 stands and selected 76 for further study. White could find only 8 sites that had been undisturbed in the previous 20 years, and none that were undisturbed greater than 35 years. He found 192 plant species including 38 species of shrubs. These are all listed. He states that all wet meadows require mowing, grazing or burning or they will be rapidly colonized by shrubs.

Zimmerman, J.H. 1983. *The Revegetation Of A Small Yahara Valley Prairie Fen.* Transactions of the Wisconsin Academy of Sciences, Arts and Letters 71(2):87-102.

This study compared undisturbed fen vegetation immediately adjacent to a fen disturbed by a sewer line installation. Includes a very good, detailed discussion of key indicator species, their growth forms, phenology and dominance.

Birds

Madison Metropolitan Sewerage District et al. 2001. *Birds of the MMSD Wildlife Observation Area (Brochure and checklist).*

This is a compilation of records of observations done by experienced ornithologists at the MMSD lagoons and wetlands in the northeast part of the study area. This is an important stopover area for many migrants. Over 200 species of birds have used this site in migration, including many state-listed and two federally listed birds (Piping Plover and Peregrine Falcon). No state listed birds were found to be breeding.

Burcar, K. Undated. *Birds of the Nine Springs E-Way*. Dane County Parks, Madison Audubon Society. Brochure and checklist.

This is a similar list, based on a year long study of the entire Nine Springs E-way. 196 species were noted. No state listed birds were found to be breeding.

On August 27, 1997 BER community ecologist Eric Epstein conducted an informal bird survey in the Nevin Wetlands (WDNR 1999). Winter bird counts, as part of the National Audubon Society Christmas Bird Count, have been conducted within the Nevin property over at least the last twenty years (Dr. Stanley Temple, personal communication). Methodology for these counts follows standard Christmas Bird Counts.

The Wisconsin Breeding Bird Atlas at the University of Wisconsin-Green Bay Department of Natural and Applied Sciences was queried. The Madison East Quad confirmed Least Bittern breeding as well as Dickcissel, both Special Concern (S3B) species. The website is http://www.uwgb.edu/birds/wbba/.